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OSTEOGENESIS IN THE GOLDEN HAMSTER

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The golden hamster, *Cricetus auratus*, first described by Waterhouse in 1893, and introduced from Syria into England in 1931, has been widely used in parasitological, bacteriological, and physiological work.

Relatively few developmental studies have been made. Samuel and Hamilton (1942) described the living eggs of the hamster. Venable (1946) discussed preimplantation stages and Ward (1948) implantation and early development. Graves (1945) studied the development of the embryo during the first nine days after fertilization, and Ortiz (1945) outlined the development of the Wolffian and Müllerian ducts and the accessory reproductive organs. Boyer (1948) described the early development of the hamster with special reference to the major circulatory channels.

A review of the literature revealed no work on the development of the hamster skeleton. The present paper is confined to the ossifications and calcifications, beginning with the twelfth prenatal day and extending through the seventh day postpartum. Details on the middle and internal ear ossifications are reserved for separate consideration.

MATERIALS AND METHODS

The hamsters used in this study were drawn from the colony of about seventy females and ten males established in the Zoology Department at Oregon State College. Most of the animals had been obtained from Quivira Specialties, Topeka, Kansas, and from the General Biological Supply House, Chicago.

The hamsters' diet consisted of rabbit pellets, rolled oats, mash, dog biscuits, apples, and vegetables, together with plenty of water and salt licks.

Embryos of known age were obtained by recording the time of matings. About 7:00 P. M. every evening during the months of November, December, January, and early February 1948–49, males were placed in the mating cages and all of the unmated females were "tried." At first, vaginal smears were attempted to determine the stage of the oestrous cycle, but it was later found to be easier to place the female in the male's cage for a few minutes and to observe for results. If no interest was displayed, the female was removed and another tried. If the females were receptive, copulation began almost at once, and was allowed to

continue for at least fifteen minutes. As soon as a female mated she was given a number and a separate cage and the time of copulation was recorded.

During the winter months it was noted that many of the females were markedly unreceptive to the males, and that a large percentage of the copulations did not result in pregnancy. Beginning in March, the sexual activity was greatly increased and the matings were consistently fertile.

Embryos were collected, beginning on the ninth day, through the sixteenth day of gestation. The mothers were sacrificed on succeeding days at approximately 7:00 P. M. Thus the series of embryos differed by progressive increments of twenty-four hours.

Post natal animals were collected on the day of birth and on seven succeeding days at an hour corresponding with the birth hour so that these specimens were also twenty-four hours apart.

TABLE 1.—*Number of specimens used in the study*

PRENATAL		POSTNATAL	
Age in Days	Number of Specimens	Age in Days	Number of Specimens
10	5	1	9
11	15	2	5
12	14	3	5
12½	6	4	3
13	20	5	6
14	8	6	4
15	9	7	5

The specimens on which this paper is based were accumulated over a period of about six months. With few exceptions, none of those of a particular age were all from the same litter. If there was a considerable variation in size, enough additional animals to establish a norm were collected for that age. It appeared that a rather characteristic size and stage of development was reached on each particular day. One hundred fourteen skeletons were prepared (Table 1).

Preparation of specimens.—Dawson's Alizarin-Red-S bone staining technic found in Lee's The Microtomist's Vade-Mecum was used with some modifications. The procedure was as follows:

1. Fix animal in 95 per cent alcohol for at least two days.
2. Skin animal if much pigmentation or hair is present, and eviscerate.
3. Place animals that have fat deposits in acetone for at least two days. Large fat depots must be picked away.
4. Replace the animal in 95 per cent alcohol for another two days.
5. Clear in aqueous KOH. The strength of the KOH varies with the size of the embryo. A solution of 0.5 per cent may be safely used on most specimens although solutions as weak as .0125 per cent are required for the smallest. Solutions as strong as 2 per cent may safely be used on larger animals. This step must be watched, and the length of time depends on the size of the animal. Prolonged baths in KOH are to be avoided to prevent maceration of soft tissues, but it is essential that the animal be thoroughly cleared before staining.
6. Stain for 24 hours or longer depending on the size of the animal.

Stock stain:

50 per cent alcohol	300 c.c.
Alizarin Red-S	0.5 grams
Glacial Acetic Acid	15 c.c.
Glycerine	50 c.c.

Add Alizarin to alcohol and dissolve; then add the acid and glycerine.

Working solution:

Dilute stock stain 2 parts to 70 parts with KOH of the same strength used for clearing.

7. Remove from the stain and wash again in KOH of the same strength used for clearing.

8. If the staining process has been governed closely, the bone will have the proper amount of stain and the tissues will be only lightly tinged with red. This tissue coloring will be removed with subsequent treatment. If the animals are overstained they may be destained in a dilute acid-alcohol solution (1 per cent H_2SO_4 in 95 per cent alcohol). Destaining should be avoided if possible, especially on young embryos. The specimen should be washed in water and then placed in acid-alcohol. This process must be watched carefully since a prolonged bath will decalcify and decolorize the bone. Wash in water again.

9. Replace in KOH.

10. Run up to pure glycerine through a graded series of KOH and glycerine prepared as follows:

Glycerine		KOH
3 parts	to	7 parts
5 parts	to	5 parts
7 parts	to	3 parts

Removal of stain from tissues occurs during this treatment and the process may be speeded up with application of low heat or by placing the clearing specimens in strong sunlight.

11. Store finished specimens in pure glycerine with a few grains of thymol.

OSSIFICATION CENTERS APPEARING IN EMBRYONIC DEVELOPMENT AND DURING THE FIRST SEVEN POSTNATAL DAYS

All references to bones in this paper concern only their ossified centers or portions. In every case the first appearance of ossification is recorded and the maximum number of centers is reported for each age.

OSSIFICATION CENTERS IN THE SKELETON, EXCLUDING THE SKULL

Gestation day 12.—The first centers of ossification appear on the twelfth day of gestation. Of the eleven embryos examined, five show a small ossifying center in the clavicle.

Gestation day 12½.—Since day 13 showed a great increase in number of ossifying centers over day 12, it was thought desirable to examine an intermediate stage. Embryos examined at 12½ days of gestation were found to have ossification in the vertebro-costal ribs, 5 through 13. The ribs grade imperceptibly in length, with the middle members of the series being longer than those toward either end.

The humerus ossifies at this age as a short cylinder in the middle of the diaphysis.

Gestation day 13 (Plate I, 1).—In addition to the previously ossifying humerus, the radius now appears as a short thin-walled tube ending abruptly in the middle of the diaphyseal cartilage. The ulna likewise makes an appearance on this day.

Ossification in the scapula begins near its vertebral end along with a portion of the spinous process, already separating the supra- and infraspinous fossae.

The three main bones of the hind limb, the femur, tibia, and fibula ossify on this day, for the first time, as small cylinders in the cartilaginous diaphysis.

Vertebrocostal ribs 1 to 4 are added to complete the series.

The first ossification of the pelvic girdle makes its appearance at this time in the ilium. Neural arches are also beginning. These consist of cervicals 1 through 7, thoracics 1 through 13, and lumbars 1 through 4.

Gestation day 14.—Two lumbar neural arches are added to make a total of six. Three sacral neural arches are present. The first ossification of vertebral bodies occurs on this day and involves thoracics 2 through 13, lumbars 1 through 6, and sacrals 1 through 2. These centra appear one day later than the first vertebral arch ossifications.

Gestation day 15 (Plate I, 2).—On the fifteenth day of gestation, the 3rd phalanx on digits 2 through 5 appear in the manus while the pes shows development of the 3rd phalanx on digits 1 through 5. These terminal phalanges are small cone-tipped cylinders. Metacarpals and metatarsals 2, 3, and 4 are present for the first time.

The two remaining bones of the pelvic girdle, the ischium and pubis, now show small ossification centers.

Cervical centra 3 through 7 appear for the first time. The first thoracic centrum is now ossifying to make a total of 13, while the addition of the 3rd sacral centrum completes that series. Four caudal centra are present. All neural arches for the above mentioned centra are formed in addition to two extra caudal neural arches.

Components of the sternum make their first appearance at this time. The posterior end of the manubrium is beginning in two separate centers. Sternebrae 1, 2, and 5 are present.

Postnatal day 1.—In the manus, phalanx 1 of digits 2, 3, and 4 appears as a thin ring of ossification in the cartilaginous diaphysis. The fifth metacarpal is also present. In some specimens metatarsals 1 and 5 are added, as is digit 1 of phalanx 1.

The vertebral column shows additions both anteriorly and posteriorly. Caudal bodies 5 to 9 are present, and all but the last four have beginnings of neural arches. Neural arches are fused to the first six tail centra, and the three sacral neural arches are fusing with their centra. The first two cervical bodies, the atlas and axis, are now present. The hypocentrum of the atlas begins as a small round center of ossification, lying midventrally within the cartilaginous ring of the atlas. The odontoid process of the axis appears as a very small spot of ossification cephalic to the ossifying center of the axis centrum.

The paired centers of the manubrium are beginning to fuse and, with the addition of sternebrae 3 and 4, that series is completed.

Postnatal day 2.—Additional ossification has occurred in the phalanges of the pes. Phalanges 1 and 2 on digits 2 through 5 complete the series. The fibulare (calcaneus) begins as a cylindrical ossification center at the bend of the hind foot midway between the posterior end of the tibia and the first phalanx of the fifth digit.

In the manus, phalanx 2 on digits 1, 2, 3, 4, and 5, and phalanx 1 on digit 5, appear in the form of the usual band-shaped ossification centers. Metacarpal 1 is also present.

The vertebro-costal portions of the ribs have ossified to the costochondral junction. The medial articulating process of the ilium is extending toward the second sacral vertebra.

Postnatal day 3.—On the third postnatal day no new bones are added, but a gradual enlargement and change in shape can be noted in the previously mentioned centers. The neural arches of the three sacral vertebrae and the first four caudal vertebrae are fused with their centra.

Nutritive foramina in the infraspinous fossa of the scapula may be seen near the spine. The verteb-arterial foramina for cervicals 3, 4, and 5 have formed by this time.

Postnatal day 4 (Plate I, 3).—A tenth caudal centrum is noted and the first five caudal bodies now have neural arches. The verteb-arterial foramina of the sixth cervical vertebra are complete. The carotid tubercle (Chassaignac's tubercle), a costal element peculiar to the sixth cervical vertebra, is distinct at this time.

In the heel, the tibiale (talus) now appears as a center of ossification at the same level, but medial to the fibulare (calcaneus).

Postnatal day 5.—There is little or no change except a general increase in size. The fifth caudal neural arches are seen fused to their centra.

Postnatal day 6.—Changes noted are the addition of phalanx 1 of digit 1 in the manus, and a minute beginning of an epiphyseal center on the proximal end of the humerus. Also, the verteb-arterial foramina of the second cervical vertebra are completed.

An hourglass-shaped os priapi or baculum was found in one male specimen.

Postnatal day 7 (Plate I, 4).—Another caudal vertebra is present to make a total of eleven.

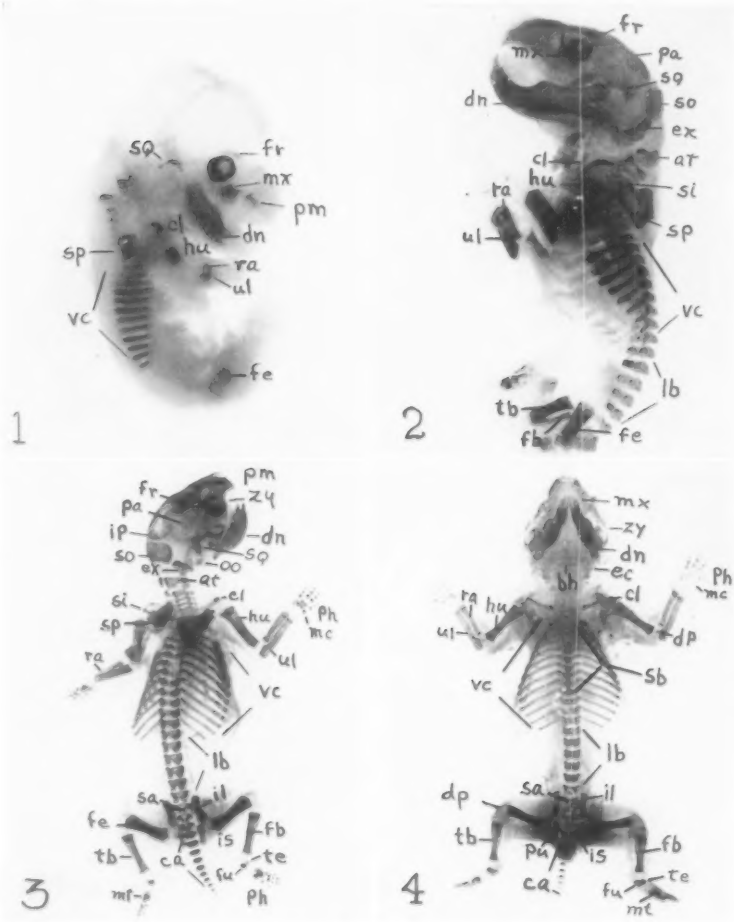

PLATE I

No. 1; 13-day prenatal, side view, × 4: No. 2; 15-day prenatal, side view, × 2.4; No. 3; 4-day postnatal, dorsal view, × 1.4: No. 4; 7-day postnatal, ventral view, × 1.2. Key to Abbreviations: at, atlas; bh, basihyal; ca, caudal; cl, clavicle; dn, dentary; dp, distal epiphysis; ec, ectotympanic; ex, exoccipital; fb, fibula; fe, femur; fr, frontal; fu, fibulare; hu, humerus; il, ilium; ip, interparietal; is, ischium; lb, lumbar; mc, metacarpal; mt, metatarsal; mx, maxilla; oo, opisthotic; pa, parietal; ph, phalanx; pm, premaxilla; pu, pubis; ra, radius; sa, sacral; sb, sternebrae; si, spinous process; so, supraoccipital; sp, scapula; sq, squamosal; tb, tibia; te, tibiale; ul, ulna; vc, vertebrocostals; vo, vomer; zy, zygomatic.

Fusion of the vertebral arches on the dorso-median line can be seen in lumbars 1 and 2, sacrals 1, 2, and 3, and caudals 1 and 2.

There is an ossification in the epiphysis at the distal end of both the femur and humerus.

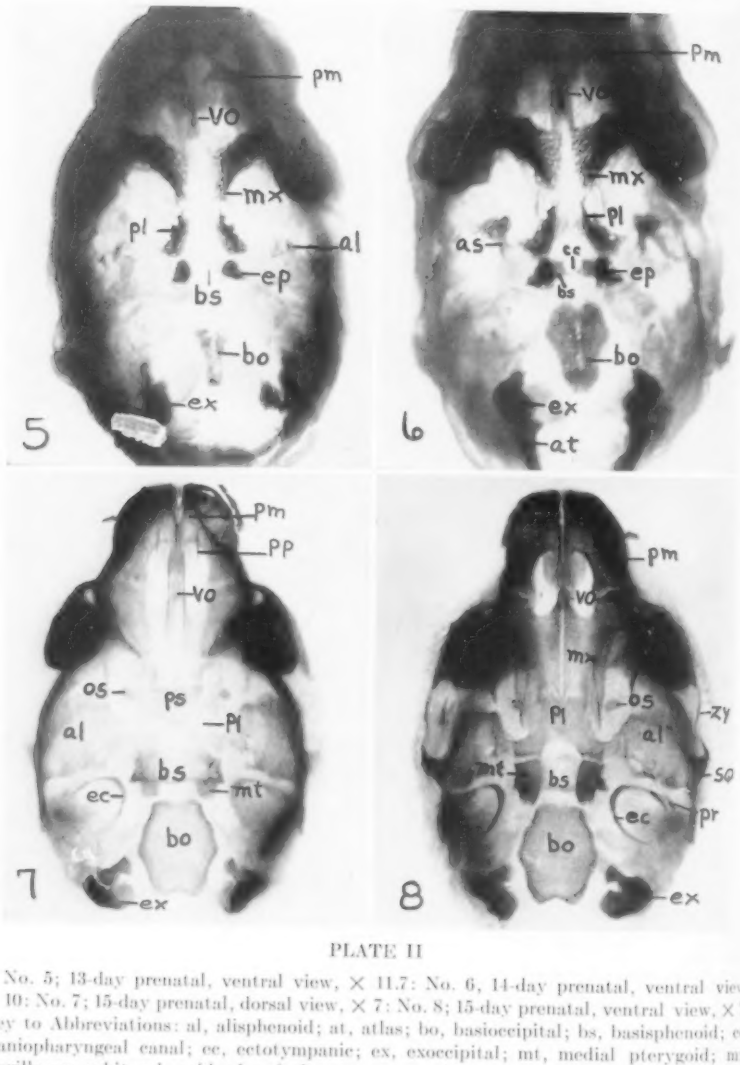

PLATE II

No. 5; 13-day prenatal, ventral view, × 11.7: No. 6, 14-day prenatal, ventral view, × 10: No. 7; 15-day prenatal, dorsal view, × 7: No. 8; 15-day prenatal, ventral view, × 7. Key to Abbreviations: al, alisphenoid; at, atlas; bo, basioccipital; bs, basisphenoid; ec, craniopharyngeal canal; ec, ectotympanic; ex, exoccipital; mt, medial pterygoid; mx, maxilla; os, orbitosphenoid; pl, palatine; pm, premaxilla; pp, paraseptal; pr, prearticular; ps, presphenoid; sq, squamosal; vo, vomer; zy, zygomatic.

The tibiale (talus) and fibulare (calcaneus) are enlarged and a center of ossification in the position of the future cuboid is added.

Three carpals are noted. These are: the ulnare (triangular), distal to the ulna; the radiale (navicular), distal to the radius; the intermedium (lunate), distal to the radius, but between the radiale and ulnare. The first sesamoid, the patella, appears at this time.

OSSIFICATION CENTERS IN THE SKULL

Gestation day 12.—The first ossification centers in the skull begin on the twelfth day of gestation. The dentary appears as a small center lateral to Meckel's cartilage toward its caudal end and the maxilla may be identified as a small irregular patch.

Gestation day 12½.—No additional centers have appeared, although those already present have extended their limits somewhat.

Gestation day 13 (Plate II, 5).—Marked progress in development has occurred and many new bone centers may be distinguished.

The dentary is rapidly investing Meckel's cartilage, both craniad and caudad. The zygomatic process of the maxilla is evident, and another separate center of ossification in the maxilla can be seen anterior to the orbit. The paired premaxillae appear as rather elongated centers anterior to the maxillae and extending toward the snout. The incisors of the upper jaw have erupted. The paired squamosals arise as slender bars from which the zygomatic process is already protruding. The frontals appear as relatively large reticular plates dorsal to the orbit.

A very small center of ossification is beginning in each of the parietals posterior to the frontals. A ventral view of the skull reveals further development. The exoccipitals have rather large centers lying on either side of the V-shaped basioccipital, the point of which is directed posteriorly. Anterior to the basioccipital, and in the same plane, the basisphenoid may be seen as a small ossification center. The medial pterygoid processes or hamuli are well developed and lie ventral to the basisphenoid on either side of the median pterygoid fossa. A pair of palatines are seen developing immediately anterior to these pterygoid processes of the basisphenoid. Lateral to the palatines the irregular centers of the alisphenoids are visible.

Midway between the developing centers of the maxillae and the premaxillae, the vomer appears as a short horizontal plate pointed at the anterior end and lying against the ventral side of the mesethmoid region. Extending from the median line of the vomer, near its anterior end, is a perpendicular keel directed ventrally toward the medial line of fusion of the palatine processes of the maxillaries.

Gestation day 14 (Plate II, 6).—New bones to appear on this day are the nasals, zygomatics, ectotympanics, and supraoccipitals.

The zygomatic manifests itself as a very slender sickle-shaped ossification-center lying free between the zygomatic processes of the maxilla and squamosal. The nasal bones ossify as two bars, one on either side of the median dorsal line. The supraoccipital arises as two circular areas connected by a slender commissure in the postero-dorsal region of the skull. The slender sickle-shaped ectotympanic lies ventro-laterally to the basisphenoid.

Further expansion of the bones of the previous day is observed. An anterior median notch occurs in the basisphenoid, and represents the incompletely established craniopharyngeal canal. The medial pterygoid on either side has contacted the basisphenoid and the line of demarcation between the two is barely visible. Both the frontals and parietals have greatly extended in area.

The dentary is approaching the squamosal; the coronoid, condyloid, and angular processes of the dentary are also evident as trabeculae directed toward their future limits. The incisors of the lower jaw have erupted. Alveoli for the molars in both the maxilla and mandible are present. A large infra-orbital foramen in the maxilla has been established.

Gestation day 15 (Plate II, 7, 8).—Paired interparietals are first represented as thin lines of scattered centers on either side immediately anterior to the supraoccipitals. The lacrimals are now apparent in the anterior wall of the orbit. The orbitosphenoids arise on either side dorso-laterally to the presphenoid and antero-medially to the alisphenoids.

The basihyal can be recognized as a median calcified cartilage in the form of a short transverse bar with a slight curvature opening dorsally.

The reptilian prearticular (processus anterior mallei of mammals in general) makes its appearance in close association with and medial to the anterior limb of the U-shaped ectotympanic as in other myomorphs.

The anterior paraseptal cartilage, in which is lodged the vomeronasal organ of Jacobson, ossifies on either side of the nasal septum. It arises in continuity with the posteromedial border of the premaxilla (anterior margin of the incisive foramen) as a vertical half cylinder longitudinally disposed with the concavity directed toward the cartilaginous septum of the mesethmoid.

Medial to the orbit, and inside the cranium, the frontal bone develops an oblique ridge directed cephalo-caudad. This pair of ridges (one on either side) contacts the cartilaginous cribriform plate of the ethmoid.

The posterior end of the zygomatic lies below the zygomatic process of the squamosal, and its anterior end lies dorsal to the zygomatic process of the maxilla.

Further extensions of bones previously described may be noted. The palatines and the alisphenoids on either side have met. The premaxillae, maxillae, and palatines have established the secondary hard or false palate. Some of the roofing bones of the skull overlap. In particular, the lateral edge of the parietal overlies the upper edge of the squamosal and the anterior edges of both the parietal and squamosal overlie the rear edge of the frontal.

Postnatal day 1 (Plate III, 9).—No new bones begin development on this day, but further extensions of bones previously established are noticeable.

The palatines have extended laterally and the alisphenoids medially to form a line of junction. The palatines have also extended caudad and have contacted the pterygoids. The pterygoid on either side has fused with the basisphenoid. The pterygoid also shows a lateral extension from its dorsal end. The lower edge of the squamosal overlies the upper edge of the alisphenoid. The orbitosphenoids have united with the presphenoid to form a sphen-ethmoid.

The condylar foramen in each exoccipital is now completed, and the interparietals are united on the median line.

The first upper molar makes its appearance and, in the mandible, the first two molars have also broken through. Mental foramina are established in the mandible.

Postnatal day 2 (Plate III, 10).—There is an ossification center in both the cephalic and caudal regions of the petrosal, corresponding with the pro- and opisthotic areas, respectively.

The tympanic bulla (entotympanic) is first indicated in a small center in its caudal aspect medial and caudal to the posterior limb of the ectotympanic.

The posterior ends of the vomer have extended back to the presphenoid. The median process of the vomer has reached the palatine processes of the maxillaries on the median line, thus dividing the nasal passage into right and left sides. The anterior blades of the vomer extend obliquely dorsally and meet the posterior ends of the medial walls of the ossified paraseptals. The posterior ends of the nasals and premaxillae have extended back over the anterior ends of the frontals, and the second upper molar has erupted.

Postnatal day 3.—The cranio-pharyngeal canal in the basisphenoid is reduced to a small aperture.

Postnatal day 4 (Plate III, 11).—Ossification is extended in both the pro- and opisthotic areas. An ossification may be seen in the free end of a finger-like process in the ethmoturbinal, on either side.

Postnatal day 5.—The tympanic bulla is nearly complete in outline. The petrosal is well advanced with its ossifying rudiments united. Each pterygoid has sent from its dorsal end a process directed obliquely toward the tympanic bulla. There are eight islands of ossification in the ethmoturbinals.

Postnatal day 6.—Ossification of the cribriform plate of the ethmoid occurs mainly in paired lateral areas; however, scattered, independent smaller ossification centers appear on either side. The main paired ossification centers show a series of perforations for the filia olfactoria (Olfactory I). All three upper and lower molars are present.

Postnatal day 7 (Plate III, 12).—The frontal and occipital fontanels are quite small and all other sutures are well established. Increased ossification in the cribriform plate of the ethmoid is noted.

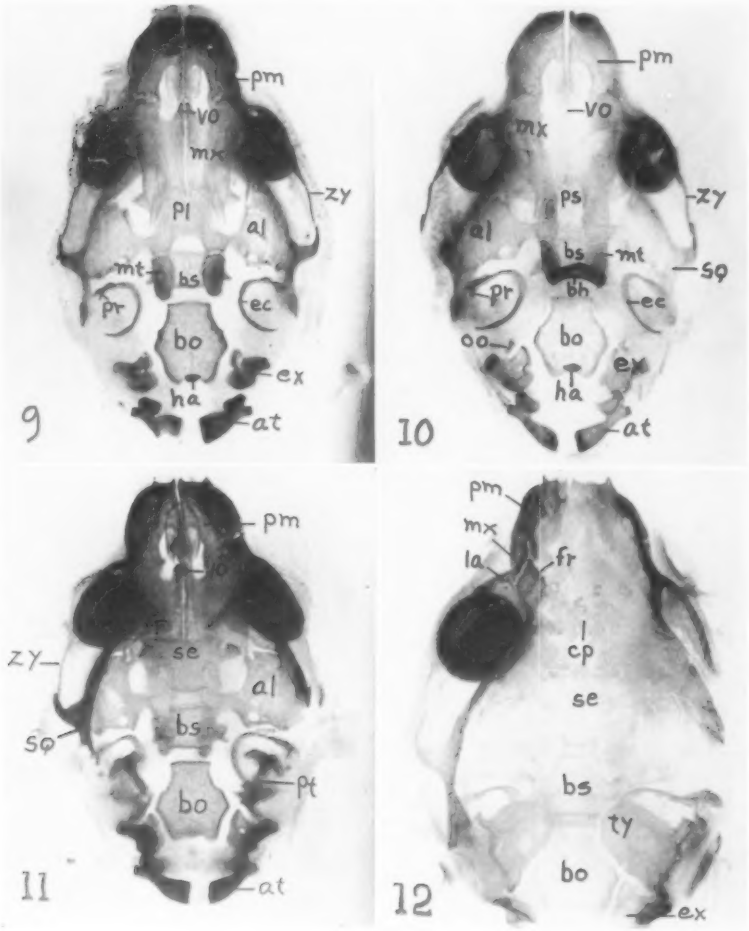

PLATE III

No. 9; 1-day postnatal, ventral view, × 6: No. 10; 2-day postnatal, ventral view, × 4.7: No. 11; 4-day postnatal, dorsal view, × 4.7: No. 12; 7-day postnatal, ventral view, × 4.7. Key to Abbreviations: al, alisphenoid; at, atlas; bh, basihyal; bo, basioccipital; bs, basisphenoid; cp, cribriform plate of ethmoid; ec, ectotympanic; ex, exoccipital; fr, frontal; ha, hypocentrum of atlas; la, lacrimal; mt, medial pterygoid; mx, maxilla; oo, opisthotic; pl, palatine; pm, premaxilla; pr, prearticular; ps, presphenoid; pt, petrosal.

ANOMALIES

Various anomalies were noted. Ribs were frequently found to have vestigial centers on either side of the first lumbar vertebrae. The arrangement of these remnants varied. Sometimes an ossification center was found on one side only;

occasionally an ossification was more extensive than its fellow. Fusions of adjacent ribs were also seen. In one specimen, of postnatal day 3, the proximal ends of ribs 10 and 11 on the left side were fused. Another specimen of the same age showed a fusion of the middle portions of ribs 7 and 8. A postnatal-day-5 animal had a pair of vestigial ribs with the rib on the left side being fused to the neural

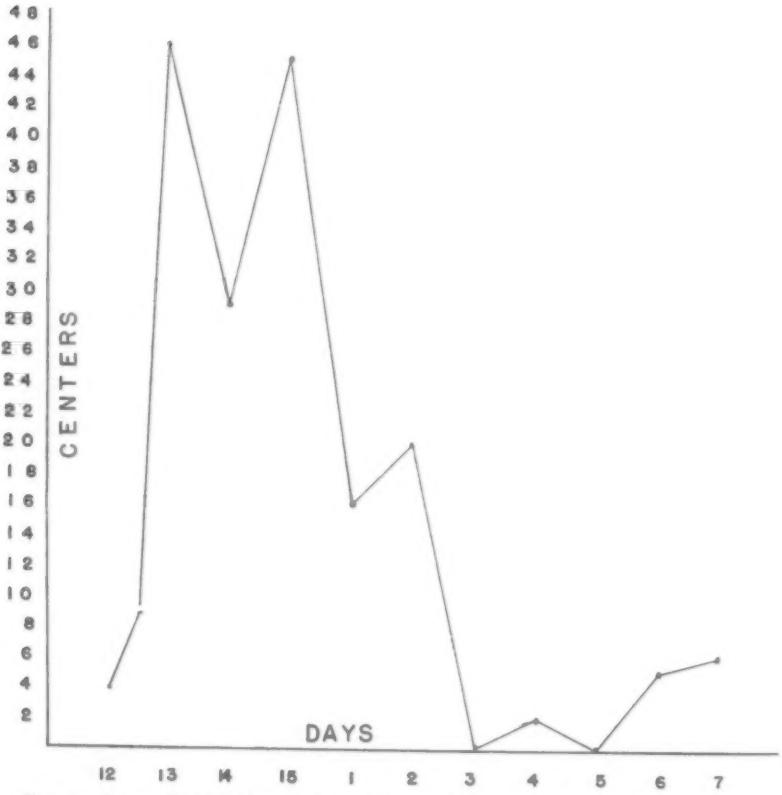

FIG. 1.—Curve showing the number of new ossification centers (median and paired) added daily from day 12 prenatal through day 7 postnatal (Golden Hamster).

arch of lumbar vertebra 1 by a slender neck of ossification. One animal of postnatal day 6 had an abnormally short thirteenth rib on the right side.

In the sternum of one specimen there were five alternating rudiments between the second and fifth sternebrae, with two rudiments on the left side and three on the right. Several specimens were found to have a third ossification center between and ventral to the regular two centers of the fifth sternebrae.

The axis centrum in two postnatal-day-1 animals was found to begin ossification in paired centers, transversely arranged.

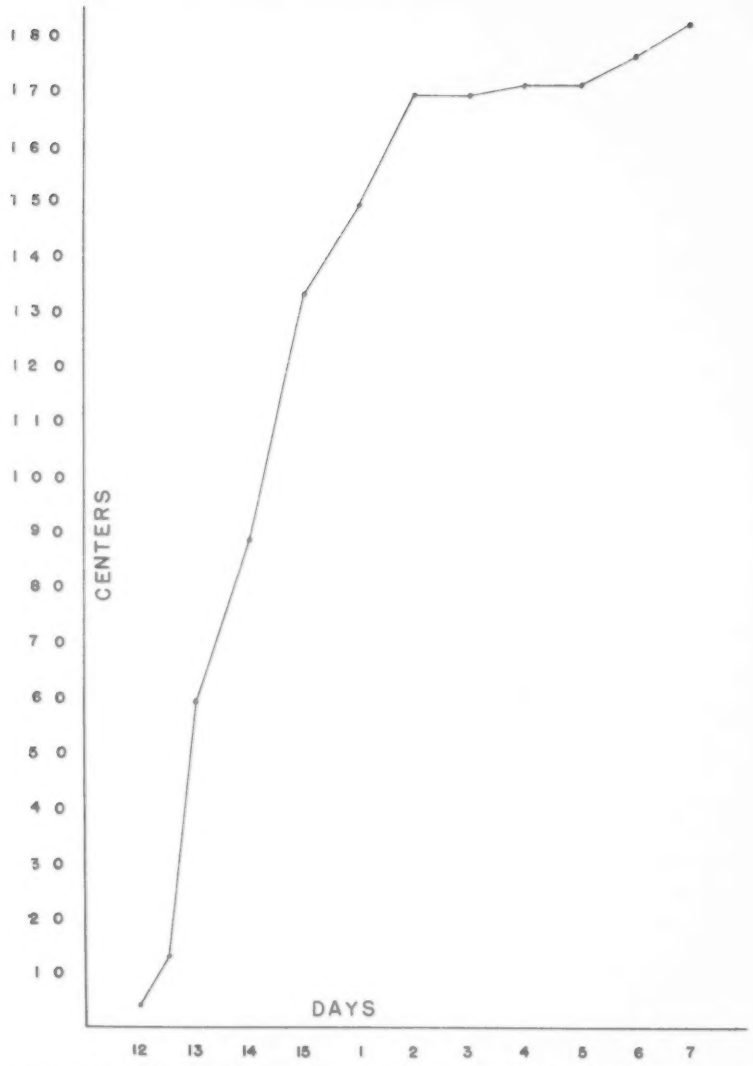

FIG. 2.—Curve showing total existing ossification centers (median and paired) on each day from day 12 prenatal to day 7 postnatal (Golden Hamster).

Several rather dense discrete circular plates of variable size were found in the walls and neck of the urinary bladders of two postnatal-day-2 animals. These structures consisted of a resistant and brittle material which took on a deep hue

TABLE 2.—*First appearance of ossification centers in the golden hamster*

OSSIFICATION CENTER	AGE IN DAYS	
	Prenatal	Postnatal
Vertebral bodies:		
Cervicals 3–7	15	
Cervicals 1–2		1
Odontoid process		1
Thoracics 2–13	14	
Thoracic 1	15	
Lumbars 1–6	14	
Sacrals 1–2	14	
Sacral 3	15	
Caudals 1–4	15	
Caudals 5–9		1
Caudal 10		4
Vertebral Arches:		
Cervicals 1–7	13	
Thoracic 1–13	13	
Lumbars 1–4	13	
Lumbars 5–6	14	
Sacrals 1–3	14	
Caudals 1–6	15	
Ribs:		
Vertebrocostals 5–13	12½	
Vertebrocostals 1–4	13	
Sternum:		
Manubrium	15	
Sternebrae 1, 2, 5	15	
Sternebrae 3, 4		1
Pectoral girdle:		
Scapula	13	
Spinous process	13	
Clavicle	12	
Pelvic girdle:		
Ilium	13	
Ischium	15	
Pubis	15	
Upper and fore arm:		
Humerus	12½	
Proximal epiphysis		6
Distal epiphysis		7
Radius	13	
Ulna	13	
Carpals:		
Radiale		7
Intermedium		7
Ulnare		7
Tarsals:		
Tibiale		4
Fibulare		2
Cuboid		7

OSSIFICATION CENTER	AGE IN DAYS	
	Prenatal	Postnatal
Metacarpals:		
First		2
Second	15	
Third	15	
Fourth	15	
Fifth		1
Hindlimb digits:		
Digit One		
Phalanx One		1
Phalanx Two	15	
Digit Two		
Phalanx One		2
Phalanx Two		2
Phalanx Three	15	
Digit Three		
Phalanx One		2
Phalanx Two		2
Phalanx Three	15	
Forelimb digits:		
Digit One		
Phalanx One		6
Phalanx Two		2
Digit Two		
Phalanx One		1
Phalanx Two		2
Phalanx Three	15	
Digit Three		
Phalanx One		1
Phalanx Two		2
Phalanx Three	15	
Digit Four		
Phalanx One		1
Phalanx Two		2
Phalanx Three	15	
Digit Five		
Phalanx One		2
Phalanx Two		2
Phalanx Three	15	
Thigh and Shank:		
Femur	13	
Distal epiphysis		6
Tibia	13	
Fibula	13	
Skull:		
Maxilla	12	
Medial pterygoid	13	
Nasal	14	

TABLE 2.—*Continued*

OSSIFICATION CENTER	AGE IN DAYS		OSSIFICATION CENTER	AGE IN DAYS	
	Prenatal	Postnatal		Prenatal	Postnatal
Metatarsals:			*Skull*—Continued;		
First		1	Palatine	13	
Second	15		Parietal	13	
Third	15		Prearticular	15	
Fourth	15		Premaxilla	13	
Fifth		1	Squamosal	13	
Digit Four			Ectotympanic	14	
Phalanx One		2	Vomer	13	
Phalanx Two		2	Zygomatic	14	
Phalanx Three	15		Chondrocranium		
Digit Five			Alisphenoid	13	
Phalanx One		2	Basisphenoid	13	
Phalanx Two		2	Basioccipital	13	
Phalanx Three	15		Cribriform plate		6
Sesamoids:			Entotympanic		2
Patella		7	Exoccipital	13	
Heterotopic:			Orbitosphenoid	15	
Os priapi (baculum)		6	Paraseptal	15	
Skull:			Petrosal		
Dermatocranium			Opisthotic		2
Dentary	12		Prootic		2
Frontal	13		Presphenoid	15	
Interparietal	15		Supraoccipital	14	
Lacrimal	15		Visceral arch cartilage		
			Basihyal (calcified)	15	

with Alizarin Red S, resembling somewhat normal ossification centers in this respect. One animal had two such areas and the other three.

Portions of the umbilical cord near the body of 14- and 15-day gestation embryos were found to contain short cylindrical areas which, like bone, took on a deep red color. These cylinders did not end abruptly, but seemed to shade imperceptibly into the unstained regions both proximally and distally. Upon manipulation with forceps, this red tissue was found to be quite yielding.

DISCUSSION

This paper deals primarily with the first appearance of ossification centers in the hamster skeleton, and the charted data (Table 2) will be found to be self-explanatory. However, it is of interest to note the correlation of the rapid rate of ossification with the precocious development of the hamster. This animal has the unusually short gestation period of sixteen days. Since the first ossification was found to begin on the twelfth day of gestation, this allows only four days of bone development before birth. During this short period, the greater portion of the entire skeleton is represented by ossification centers, and in many cases the characteristic shape of the definitive structure may be seen. To emphasize the

"explosive" appearance of the representative elements of the skeleton, attention is referred to Figure 1 in which the daily increments of new centers are plotted against days prenatal and postnatal, and also to Figure 2 in which total centers existing on each day are indicated for the same period of development.

By the time of birth, the vertebrae are well represented, but the degree of fusion of the elements is insignificant even through the seventh postnatal day. All bones of the pelvic and pectoral girdles are represented before birth and the sternum is complete except for the last two sternebrae, which ossify on the first postnatal day. The long bones of the fore and hind limbs are well developed before birth, but epiphyseal centers do not begin until the sixth and seventh postnatal days. Tarsals and carpals begin ossification toward the end of the first postnatal week. Some of the phalanges of both the fore and hind limbs begin to ossify prenatally, but most of them do so in the early postnatal days.

By the time of birth, most of the bones of the adult skull are represented. Three bones, the petrosal, entotympanic, and cribriform plate of the ethmoid appear during the first week of postnatal life. At the end of the first seven postnatal days the skull bones have greatly expanded and sutures are established.

Rapid ossification is coupled with a rapid increase in body size, and both occur during such a short period of time that the development of the hamster may be spoken of as "explosive."

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THE BLACK BEAR AS A PREDATOR OF MAN

By S. C. Whitlock

There are many written accounts and stories of encounters between humans and bears in which the animal has appeared to be the aggressor. In practically all the instances on record which I have been able to find there have been extenuating circumstances. Most often the attacks have been made by "tame" bears who had lost their fear of man by close association. Park or zoo bears have been guilty of such attacks on several occasions. In a number of instances, female bears with cubs have threatened, charged, and actually attacked humans presumably because of their mother's protective instinct. Bears wounded by hunters or chased by dogs have many times turned and attacked their tormentors.

Seton relates one example among all the cases which he investigated in which a wild bear attacked, without provocation, a human being, apparently with the idea of obtaining food, although the victim was not actually eaten. It is the only case which this noted authority has accepted as authentic. It took place in Northern Canada more than forty years ago (1908).

Near Sault Sainte Marie, Michigan, on July 7, 1948, there occurred an instance of an attack by a bear on a human which as far as can be ascertained is without parallel except for Seton's account. All the circumstances and conditions surrounding this situation indicate that here was an example of true predation by a black bear on the human species in which the objective was simply to obtain food.

The tragic aspects of this case are such that it is reported with some hesitation, and it has been intentionally delayed so that the passage of time might alleviate to some extent the mental anguish of those intimately connected by close relationship to the unfortunate victim. There seems to be no reasonable objection now to a factual report more than a year later of this unique occurrence.

The mother of the three-year-old victim of this savage attack gave an account to a forest ranger immediately afterwards. Her own words tell the story more graphically than does a second-hand account. It is quoted verbatim. The account of Mrs. Arthur Pomranky follows:

"On July 7, 1948, at approximately 2:30 P.M., I was in the kitchen of our cabin at Mission Hill in company with Mrs. Merlin Summers, a friend. I was sitting about four feet from the back door with my back to the south wall of the kitchen, and Mrs. Summers was in the middle of the kitchen ironing clothes. Mrs. Summers was facing south or to the rear of the room, and in line with the back windows, although from her position, could not see the rear yard. My son, Allan, was playing in the basement which is directly under the kitchen, but which has an outside entrance. My daughter, Carol Ann, was playing in the back yard, and had been for the most of the time she was outside, in the close vicinity of the back porch. My first indication that anything was wrong was when I heard Carol Ann utter a cry of alarm, I ran to the back door, which was open with the screen door closed.

Carol Ann, when I reached the door, was on her hands and knees on the porch with one hand touching the screen in the door, and a bear was about mid point up the three steps of the back porch. The bear growled showing his teeth and grabbed Carol Ann with his mouth and pulled her off the porch onto the ground where he picked her up by the arm with his mouth. At this point, Mrs. Summers pulled me from the door and shut the inside door.

I ran for my husband's pistol, a 32–20 Colt revolver, but in my excitment could not load the pistol. I ran to the door, but the bear and child had disappeared into the bushes. I did not see in which direction the bear went. I ran to the telephone, and called the Ranger Station at Raco, and told Mr. Elliott what had happened. They went into the woods to look for the bear as soon as they arrived."

The story of Alex Van Luven, a former state trapper and widely known woodsman, who organized and conducted the hunt for the bear also seems interesting enough to quote as he told it. Mr. Van Luven's account follows:

"On the afternoon of July 7, 1948, at approximately 3:10 P.M., Ranger Bruce Elliott of the Raco Ranger Station notified me and a party of seven men who were working at the Ellis Wilcox Mill at Iroquoid Point, that a bear had taken the Pomranky child into the woods from the Mission Hill fire tower cabin. The other men from the mill crew left for the scene immediately, and I drove to my home in Brimley, a distance of nine miles, to get my dog, a three year old Labrador Retriever. I got the dog and quickly drove to the Mission Hill Tower. No one except three men had as yet gone into the woods as the searchers who had assembled in my absence were instructed by Alex Goldade and Deputy Sheriff Randolph Wilson to wait until I had returned with the dog. I took four men from the group, instructing the men to stay behind me and the dog and instructed the balance of the men to stay out of the woods until I sent word to them as to what do do. I traveled in a westerly direction from the cabin, as no one at the cabin could definitely say as to which direction the bear had gone. At a point approximately 100 yards west of the cabin the dog apparently scented the bear, and almost simultaneously one of the three men who had preceded me into the woods shouted from a distance of about sixty yards, and in a southerly direction. I went to where the men were and discovered blood spots, one of the child's shoes, and noticed that the leaves had been disarranged at that spot. The dog at this point pulled strongly in a northwesterly direction and I followed the dog about one hundred fifty feet and discovered the child's body. The body lay face upward, with the head reclining against the foot of an 8" scrub oak. Part of the clothing remained, a shirt still worn, but rolled down on the arms from the top, and rolled up from the bottom to form a ring around the childs chest. The child still wore pants, but they were pulled down about the ankles. Neither article of clothing was badly torn. The abdomen was completely removed as well as the stomach and intestines, and the front part of both legs eaten away to the knees, also the left calf. No blood was in evidence and leg bones were clean and visible. One length of intestine about eight feet long was caught on a piece of brush near the body, but was disconnected from the body. Numerous deep gashes appeared about the head and neck, however, little damage had been inflicted on the face. One tooth mark appeared about an inch behind, and in line with the left eye and had an appearance of depth sufficient to reach the brain. Both eyes and mouth were open. I instructed two of the men to return to the tower site and report the finding of the body and to direct the searchers to a road west of me as I thought the bear would travel in a westerly direction. I also instructed another man, Wayne Weston, to stay with the body. The dog appeared eager to continue the trail, so I unleashed my dog who disappeared into the dense second growth hardwood. At about 50 yards he seemed to have lost the trail making it apparent the bear had reversed direction or turned. My dog was joined with a police dog at this point, who belonged to the man who remained with me, and distracted my dog to the extent that I had the man take his dog farther south. Shortly, after the other dog left, my dog again appeared to take up the bear trail, going north. I followed the dog over a steep ridge and lost track of the dog. I walked about 100 yards northwest and saw a bear track going in the direction I had left the body, and had barely started following the track when I heard five shots. I ran to where the body was and discovered that the bear had returned to the body and had been shot by Wayne Weston. The bear weighed about 125 pounds and was very thin. I returned to the cabin and got Randolph Wilson and Harry Holdsworth and we went to where we left the body and carried it out and put it in Holdsworth's car."

The bear was taken to Sault Sainte Marie by Conservation Department officers where the County Coroner and a veterinarian opened the stomach. Fragments of human flesh were readily identified and the identity of the animal established beyond question. The stomach was placed in a preserving solution and the carcass in a cooler. It was flown to Lansing the next morning and brought to the Conservation Department Laboratory for further examination.

Nothing was found at the autopsy or in subsequent studies on microscopic sections of the brain and spinal cord to give any clue to the cause of the abnormal behavior of this animal. As previously noted, the animal was very thin. No fat was present in any of the normal fat depots e.g., mesenteries, perirenal region,

PLATE I

Towerman's cabin, showing back steps from which child was taken

etc. Aside from the human remains, the stomach contained nothing except a few ants and a little grass. The intestines were also practically empty. The stomach contents weighed three pounds and ten ounces. Most of the material consisted of str ps of skin with the attached subcutaneous fatty layer. There were also a number of muscle portions, a few bone chips, and two or three small sections of the intestine identified by omental tags as the colon.

Lacking any definitive evidence one can only speculate as to the reason for this occurrence. There were no marks on the animal to indicate that it had ever been held in captivity nor do we know of any animals being released in that region. Thus, there is no evidence to support the captive or "tame" bear thesis.

There were no garbage dumps around the house. The family dog was fed on the kitchen scraps. The parents denied ever putting out food of any type for wild animals. The father had seen bear tracks in the vicinity, but never had ac-

tually seen any bears. Bears had been seen three miles away around a township dump. As can be seen from the picture of the house (Pl. I) it would be possible for a bear to approach it rather closely in the thick second growth of hardwood which occurs within forty feet of the house.

This bear may have been in the habit of patrolling the immediate area. There must have been an occasional item of food for such an omnivorous animal as a bear. The combination of proximity to its normal range, extreme hunger, and the sight of a child much smaller than itself could conceivably account for the event that followed. In addition, I think we must postulate that here was an animal with an abnormal mental make-up. The vast majority of bears flee the presence of man with great alacrity. However, occasionally in the wild an individual is met that respects its own physical prowess to the point where it does not give the right of way even to the awe-inspiring *Homo*.

Michigan Department of Conservation, Lansing 13, Michigan, Received August 19, 1949.

THE EXTERNAL PARASITES OF THE SHORT-TAILED SHREW, *BLARINA BREVICAUDA* (SAY)

By E. W. Jameson, Jr.

The short-tailed shrew, *Blarina brevicauda* (Say), is our largest soricid, and is one of the most numerous small mammals in the northeastern United States and southeastern Canada. It is at home in a variety of habitats, and shares runways with moles, long-tailed shrews, and several kinds of rodents. Eadie (1944, 1948) emphasized that this shrew is sometimes a predator of other small mammals; this habit is reflected in its fauna of external parasites. Among these parasites are fleas and mites; lice are not known from North American shrews. In addition to external parasites blarinas may harbor arthropods which are commensal or perhaps even symbiotic.

Four-hundred and five short-tailed shrews were examined (Table 1); specimens were collected in Welland County, Ontario, and Tompkins County, New York (in the account of species these localities are designated "W" and "T" respectively). In Welland County shrews were trapped in a grassland and a woodland; in Tompkins County shrews were obtained only in woodlands. Other small mammals trapped with shrews in Welland County were the Brewer's mole (*Parascalops breweri*), eastern chipmunk (*Tamias striatus*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), and pine vole (*Pitymys pinetorum*). In Tompkins County, in addition to the above species, there were the long-tailed shrew (*Sorex cinereus*), smoky shrew (*S. fumeus*), red-backed vole (*Clethrionomys gapperi*), and woodland jumping mouse (*Napaeozapus insignis*). The important fact to be noted is that cricetine and microtine rodents occurred in both localities, and that in one locality other shrews were taken along with blarinas. The least shrew, *Cryptotis parva*, was not found in either locality although it occurs in the grasslands of Tompkins County.

In an ecological sense a small mammal is a habitat for a community of arthropods. These communities are roughly, but not strictly, comparable to habitats or environments as customarily considered by vertebrate zoologists. While all blarinas are alike (for the purpose of this investigation), they do not all live in identical environments. This is of prime importance in considering such arthropods as trombiculid mites or fleas which are parasitic only in one stage of their life cycles. As woodlands, grasslands, swamps, and marshes are interspersed within a given geographic region, so moles, shrews, mice, and voles are found to dwell side by side. In this study only one environment, that afforded by the pelage of the short-tailed shrew, is discussed. However, I have collected external parasites from the small-mammal associates of blarinas; such information assists in evaluating the ecological status of the species of arthropods discussed below.

MITES (ACARINA)

Parasitism has developed in several diverse families of mites; and some characteristically associated with small mammals appear not to be parasitic. Although ticks (Ixodoidea) have been collected from blarinas, none was found in this study.

TABLE 1.—*Collection dates of 405 specimens of Blarina brevicauda (Say) examined for external parasites*

YEAR	NUMBER OF SPECIMENS											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1946	—	—	—	—	—	—	—	32	32	—	—	—
1947	6	7	2	—	3	12	20	33	85	38	44	10
1948	3	7	7	—	11	53	—	—	—	—	—	—
Totals	9	14	9	0	14	65	20	65	117	38	44	10

PARASITIDAE

Unidentified specimens (*Parasitus* sp.) of this family were found commonly at all seasons; 100 nymphs and 17 females were collected. These mites are predators of smaller mites. Their relationship to shrews is not known, but possibly they are symbionts, reducing the number of parasitic mites.

LAELAPTIDAE

These are conspicuous parasites, superficially similar to the above. Frequently only the female of a species is parasitic; in such instances there is a marked sexual dimorphism in the mouthparts. Three subfamilies are represented.

HAEMOGAMASSINAE

Euhaemogamasus liponyssoides (Ewing).—Two hundred and one specimens; 69 males, 59 females, and 73 deutonymphs (W, T). Nymphs and both sexes are haematophagous. Other insectivores and small rodents are also parasitized.

E. microti (Ewing).—One female (T). Voles (*Microtus pennsylvanicus* and *Pitymys pinetorum*) are frequent hosts to this species.

Haemogamasus alaskensis Ewing.—Seventy-nine specimens; 74 females, 1 male, and 4 deutonymphs (W, T). Males and nymphs are apparently not parasitic. This mite commonly occurs on voles.

LIPONYSSINAE

Myonyssus jamesoni Ewing & Baker.—Sixty-nine specimens (W, T). Females outnumbered males, but both sexes are parasitic. The short-tailed shrew is the only mammal commonly parasitized; two nymphs were taken from *Sorex fumeus*.

Hirstionyssus sp.—Thirty specimens, all females (T). This species is one of many (mostly undescribed) which parasitizes small mammals. The kind on blarinas may be restricted to this host, but similar, if not identical, specimens have been taken from *Sorex palustris*.

LAELAPTINAE

Eulaelaps stabularis (Koch).—Twenty-four specimens, all females (W, T). Various small mammals in Europe and North America are hosts to this mite.

Haemolaelaps glasgowi (Ewing).—Twenty-nine specimens; 26 females and 3 males (W, T). Many species of small mammals are parasitized by this mite, but rodents seem to be the true hosts. Specimens on blarinas occurred only singly and are doubtless wanderers from wild mice.

Laelaps kochi Oudemans.—One female (W). This is a Holarctic species on voles; it is common on *Microtus pennsylvanicus* and *Pitymys pinetorum*.

Generally the parasitic laelaptids are widespread geographically. Of the above species all except *Myonyssus jamesoni* and perhaps *Hirstionyssus* sp. occur in North America from coast to coast. Occasionally non-parasitic laelaptid mites are found on shrews. Among those recorded in this study are *Lasioseius* sp., *Laelaspis* sp., *Ameroseius corbicula* (Sowerby), *Hypoaspis murinus* Strandtmann and Menzies, and ? *Typhlodromus* sp. Some of them are believed to be myrmecophilous; they could be carried to shrews by ants that come to feed on the dead animals in the traps.

MYOBIIDAE

All stages (including the egg) are attached to the hairs of the host. Like lice, specimens of this family leave a host only to crawl onto another host. The food of adults varies, but the nymphs and larvae possess tubular mouthparts, apparently to penetrate to the base of the hair to the sebaceous gland. A marked host specificity is frequently observed.

Protomyobia claparèdei (Poppe).—This species occurs on blarinas and on one species of long-tailed shrew, *Sorex cinereus*. Tentatively these specimens are considered conspecific with those from *S. araneus* of Europe.

Myobia simplex Ewing.—This mite is confined to *Blarina brevicauda* but, unlike the above species, is a blood-sucker. Both species of myobiids are almost always to be found on a shrew, but, because of their small size, they are seldom collected. Up to 300 have been found on a single host, and in such instances the host is always an old individual.

TROMBICULIDAE

In chiggers the larva is parasitic and the nymphs and adults are free-living. A species of chigger, therefore, must find a suitable environment for the nymphs and adults as well as a proper host species for the larvae.

Euschöngastia blarinae (Ewing).—This chigger is common on *Blarina brevicauda*, *Sorex cinereus*, and *S. fumeus* (W, T).

Trombicula jamesoni Brennan.—This species has apparently the same host distribution as *E. blarinae* (W, T). These two species commonly occur in the conch.

Comatacarus americanus Ewing.—Shrews in Welland County were commonly infested with this chigger; this species was found deeply embedded in the skin of the inguinal region.

LISTROPHORIDAE

According to Trouessart (1918: 151) listrophorid mites are commensals, but that would seem to depend upon their effect on the host, and this is most difficult to determine. These mites are adapted for clinging to the hairs of the host, either by valve-like structures or by modified legs, and they apparently feed on sebaceous secretions.

Listrophorus sp.—This is by far the most numerous ectoparasite on blarinas. Only this species was observed to outnumber myobiid mites, and shrews with an estimated 500 *Listrophorus* were trapped. They occur most frequently in the region of the side glands.

Myocoptes sp.—This mite is less common than the above, and is more generally distributed on the body of the host.

PEDICULOIDIDAE

? **Resinacarus** sp.—This mite is frequently present on small mammals, but seldom numerous. Apparently it is not parasitic.

BEETLES (COLEOPTERA)

None of the following beetles is known to be parasitic, but their occurrence on shrews seems worthy of comment. Carrion beetles, doubtless attracted to the dead shrews, were *Catops basilaris* Say, *Nemadus hornii* Hatch, *Xestipyge geminatum* (LeConte), and *Stelidota otomaculata* Say.

LEPTINIDAE

Leptinus americanus LeConte.—Nine specimens (T). Werner and Edwards (1948: 52) stated that specimens from eastern North America should be referred to LeConte's species rather than to *testaceous* (Müller), a European species. This beetle was taken in all seasons of the year. In addition to the specimens from short-tailed shrews, specimens were taken from Brewer's moles, smoky shrews, and red-backed voles. Whether this beetle is parasitic or not has never been satisfactorily established. *Leptinus americanus* has been found in the nests of bumblebees, but this does not preclude the possibility that it is a true parasite of small mammals. The related genus *Leptinillus* and genera of closely allied families (*Platypsylla* of the Platypsyllidae and *Amblyopinus* and *Edrabius* of the Staphylinidae) are ectoparasites of mammals. Werner and Edwards (*op. cit.*) found *Leptinus* on living shrews. The specimens which I found ran through the fur of the shrews with the agility of fleas, and were obviously quite at home on the mammals.

FLEAS (SIPHONAPTERA)

Adults are blood-sucking parasites of birds and mammals, but the eggs, larvae, and pupae occur in nests of their hosts, and are not parasitic. Although the presence of adult fleas requires the proper host, environmental factors other than the host apparently affect the pre-adult stages of fleas. For this reason the geographic and local distribution of fleas does not necessarily coincide with that of their hosts.

DOLICHOPSYLLIDAE

Orchopeas leucopus (Baker).—Four specimens (W, T). This species is a well known parasite of native mice, especially *Peromyscus* spp.

Peromyscopsylla scotti I. Fox.—Five specimens (T). This is another common flea of deer mice, and is not typical of the flea fauna of shrews.

HYSTRICHOPSYLLIDAE

Doratopsylla blarinae C. Fox.—Seven hundred and forty specimens (W, T). This is the most common flea on the short-tailed shrew. The smoky shrew is also a host, and specimens are occasionally found on moles and mice. The data (Table 2) indicate that this is essentially a flea of the warm months.

Ctenophthalmus pseudagyrtes Baker.—Two hundred and ninety-five specimens (W, T). This is second only to the next above in abundance on blarinas. There seems to be no marked seasonal difference in numbers of this flea. Many small mammals are parasitized by this flea, but it seems to favor insectivores and microtine rodents.

Hystrichopsylla tahavuana Jordan.—Thirteen specimens (W, T). The host distribution is like that of *C. pseudagyrtes*, but it is much less common than the latter.

Atyphloceras bishopi Jordan.—Two specimens (W, T). This species is found on shrews and microtines. Its apparent scarcity does not indicate that it is accidental on blarinas; it occurs with about the same frequency on meadow voles, pine voles, and red-backed voles.

TABLE 2. *Seasonal distributions of three species of fleas on Blarina brevicauda (Say). Upper figures indicate the mean number of fleas per shrew; total numbers of fleas collected are in parentheses*

FLEA SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Nearctopsylla genalis	0.6 (5)	0.2 (3)	0.2 (2)	—	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.1 (1)	0.1 (6)	0.4 (4)
Doratopsylla blarinae	0 (0)	0.1 (1)	0.1 (1)	—	2.0 (28)	2.8 (184)	1.7 (33)	2.3 (150)	2.2 (261)	1.7 (22)	0.9 (49)	0.9 (11)
Ctenophthalmus pseudagyrtes	0.6 (5)	1.6 (23)	3.1 (28)	—	0.9 (13)	0.4 (27)	0.6 (12)	0.6 (42)	0.5 (55)	0.3 (11)	1.3 (55)	2.4 (24)

TABLE 3. *Relative host specificities of the external parasites of Blarina brevicauda (Say)*

RESTRICTED TO BLARINA BREVICAUDA (1)	RESTRICTED TO SORICIDAE (2)	STRAYS FROM WILD MICE (3)	WITH SPECIFICITIES POORLY DEVELOPED OR UNKNOWN (4)
Myonyssus jamesoni	*Doratopsylla blarinae*	*Orchopeas leucopus*	*Ctenophthalmus pseudagyrtes*
Myobia simplex	*Nearctopsylla genalis**	*Epitedia wenmanni*	*Hystrichopsylla tahavuana*
	Hirstionyssus sp.*	*Peromyscopsylla scotti*	*Atyphloceras bishopi*
	*Protomyobia claparèdei***	*Euhaemogamasus microti*	*Catallagia borealis*
	Euschöngastia blarinae	*Haemolaelaps glasgowi*	*Euhaemogamasus liponyssoides*
	Trombicula jamesoni	*Laelaps kochi*	*Haemogamasus alaskensis*
	Listrophorus sp.		*Eulaelaps stabularis*
	Myocoptes sp.		*Comatacarus americanus*

* Perhaps also to Talpidae. ** Not on all Soricidae.

Epitedia wenmanni (Rothschild).—Thirteen specimens (W, T). This is common on deer mice, and is not typically a shrew flea.

Catallagia borealis Ewing.—Two specimens (T). Little is known of the host preference of this apparently scarce flea. Red-backed voles are also parasitized.

Nearctopsylla genalis (Baker).—Twenty-one specimens (T). Although few shrews were examined in the winter months, this flea was found only at that time (Table 2). It was completely absent in the warm months.

Several additional ectoparasites, congeneric with some of those typical of blarinas,

occurred frequently on other small mammals in the areas studied. *Doratopsylla hamiltoni* Traub occurs in Tompkins County, New York. Although it occurs there on the least shrew, it can also be a common parasite of blarinas (Jameson, 1947: 140). The absence of *D. hamiltoni* on the short-tailed shrews examined in this study is probably because all trapping was conducted in woodlands where the least shrew does not occur. *Protomyobia brevisetosa* Jameson is common on the smoky shrew, but on no other host in the area studied. *Euschöngastia peromysci* (Ewing) is common on jumping mice, white-footed mice, and red-backed voles, but does not occur on shrews. *Trombicula* sp. (cf. *harperi* Ewing) was found on jumping mice, and *Hirstionyssus* sp., distinct from that on blarinas, occurred on Brewer's moles. *Listrophorus* sp., unlike the form on shrews, occurred on voles, while *Myocoptes* sp., also different from that on shrews, was found on white-footed mice, jumping mice, and voles. *Euhaemogamasus microti* (Ewing), common on pine voles, was taken but once on blarinas.

DISCUSSION

Lack (1944) and Elton (1946) have emphasized the tendency for congeneric species of animals to be ecologically isolated. In a study of a tropical avifauna, Moreau (1948) extended this concept to include not only congeneric species, but, in many instances, species of different genera, but belonging to the same family. The study of a community of external parasites may or may not be quite comparable to the above-mentioned investigations: the generic and family limits of these animals are not nearly so well settled as in higher vertebrates. In the treatment of the mites and fleas I have attempted to use generic and family concepts which approximate the caliber of those employed by vertebrate zoologists.

The external parasites of *Blarina brevicauda* (Table 3) include a myobiid mite and a laelaptid mite which are restricted to that host (column 1); one myobiid mite, two trombiculid mites, two listrophorid mites, one laelaptid mite, and two hystrichopsyllid fleas common to soricid shrews in the area studied (column 2); and one trombiculid mite (*Comatacarus americanus*), two laelaptid mites (*Euhaemogamasus liponyssoides* and *Haemogamasus alaskensis*), and one hystrichopsyllid flea (*Ctenophthalmus pseudagyrtes*) common on blarinas and some other small mammals (column 4 in part). Thus, there are fourteen species of external parasites which comprise the fauna of external parasites of the short-tailed shrew. (This fauna may be augmented by future collections, and is certainly not the same throughout the geographic range of this mammal.) Of these fourteen genera none is monotypic, but some are represented locally by only a single species. Locally monotypic genera are *Comatacarus*, *Myobia*, *Myonyssus*, *Haemogamasus*, *Nearctopsylla*, and *Ctenophthalmus*; for these genera it would be quite impossible for blarinas to have more than one species each. But of the remaining eight genera it is theoretically possible for more than one species to be parasitic on short-tailed shrews.

There is some ecological segregation among the fourteen kinds of ectoparasites. In most of the families encountered there are two species each; of the laelaptid mites there are two species for each of two subfamilies; and of the hystrichopsyllid fleas there are three species. Within the families, or the subfamilies of the Laelaptidae, the genera parasitizing blarinas differ in occurrence or habits.

In the Myobiidae, *Protomyobia claparèdei* feeds on sebaceous secretions and *Myobia simplex* is a blood sucker. In the Trombiculidae, *Comatacarus americanus* occurs in the inguinal region whereas *Trombicula jamesoni* and *Euschöngastia blarinae* attach in the ears. Of the Listrophoridae, *Listrophorus* favors the region of the side glands while *Myocoptes* tends to be generally distributed throughout the pelage. Of the laelaptid mites the Liponyssinae is represented by a rather large kind, *Myonyssus jamesoni*, and a much smaller species, *Hirstionyssus* sp.; and the Haemogamassinae has one species with stout, toothed chelicerae, *Haemogamasus alaskensis*, and one species with slender, shearlike chelicerae, *Euhaemogamasus liponyssoides*, suggesting a different type of feeding. The hystrichopsyllid fleas include a strictly winter species, *Nearctopsylla genalis*, an essentially summer species, *Doratopsylla blarinae*, and a species which is active throughout the year, *Ctenophthalmus pseudagyrtes*. It is perhaps significant that the last-named species is commonly found on many kinds of small mammals. The kinds of mammals known by me to be parasitized *commonly* by *C. pseudagyrtes* include no strictly nocturnal hosts, such as *Peromyscus*.

It appears that the composition of the community of external parasites on *Blarina brevicauda* resembles the composition of communities of some groups of higher animals. The common genera are each represented by a single species. There is information to indicate that within a given family the species compete on a limited scale or not at all. This situation is not universal with faunas of external parasites for Ferris (1930:1024), reporting on Mallophaga from *Procavia adolfi-friederici*, stated that "*. . . six species, some of which at least are quite closely related* [congeneric], *occur together on a single host individual.*"

The more mobile arthropods such as laelaptid mites and fleas can be found generally distributed in the pelage of the host, but seem to concentrate on the rump and rear of the thighs. This is perhaps because of the longer hairs in this region, and because a shrew does not possess the human facility for scratching this part of its anatomy.

Records of "stray" ectoparasites on shrews need no species explanation. There are numerous situations which would make temporary transfers possible. The simultaneous presence of *Orchopeas leucopus* and *Haemolaelaps glasgowi* on a shrew could mean that it has taken the nest of a *Peromyscus*, or that it had recently killed one. The scarcity of ectoparasites on the "wrong" host attests for the well-developed specificity of the parasites.

The abundance and frequency of occurrence of external parasites have been stated in general terms and not in numerical indices except to show the seasonal distributions of some fleas. Such "precise" data tend to cloud our understanding of the numbers of these parasites. Variations in numbers of fleas and mites is considerable at any particular season. Two shrews, taken in traps a few feet apart, might have thirty and no fleas, respectively. With the mites the extremes are sometimes of much greater magnitude. Extremes are much more frequent than is expected in a normal distributional pattern of a uniform sample. For an intelligent analysis of the populations of external parasites we must first attempt to ascertain the factors affecting frequency and abundance; and then analyze the data according to the season of the year, age of the host, locality,

or whatever criteria seem appropriate. Suitable criteria will become evident only by a more profound knowledge of the biology of the host species, and by recording more information when collecting parasites.

In the identification of the arthropods discussed in this report I have received help from Drs. E. W. Baker, James M. Brennan, R. W. Strandtmann, and Capt. H. L. Keegan (Acarina), and Dr. Henry Dietrich and Ross H. Arnett, Jr. (Coleoptera).

SUMMARY

1. In Welland County, Ontario, and Tompkins County, New York, 405 short-tailed shrews, *Blarina brevicauda* (Say), were examined for external parasites.

2. One flea (*Nearctopsylla genalis*) is strictly a winter species, a second species (*Doratopsylla blarinae*) is essentially a summer flea, and a third (*Ctenophthalmus pseudagyrtes*) occurs throughout the year.

3. Of the external parasites typical of the short-tailed shrew two species (*Myonyssus jamesoni* and *Myobia simplex*) are restricted to it; eight species (*Protomyobia claparèdei, Euschöngastia blarinae, Trombicula jamesoni, Myocoptes* sp., *Listrophorus* sp., *Hirstionyssus* sp., *Doratopsylla blarinae*, and *Nearctopsylla genalis*) are more or less restricted to, and characteristic of, soricid shrews; and four species (*Euhaemogamasus liponyssoides, Haemogamasus alaskensis, Comatacarus americanus*, and *Ctenophthalmus pseudagyrtes*) parasitize blarinas, but are also common on unrelated small-mammal associates.

4. Taken as a community, the external parasites of the short-tailed shrew resemble at least some communities of higher animals in the strong tendency for an absence of intrageneric competition. The species of a given family differ in their occurrence and in their feeding habits or food.

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Div. Zool., Univ. Calif., Davis, California. Received June 3, 1949.

THE LEAST WEASEL IN WISCONSIN

By James R. Beer

The least weasel, *Mustela rixosa allegheniensis* (Rhoads), was first reported in Wisconsin by Ward (1907). This specimen was taken at Burlington, Racine County. Ward also recorded the second and third specimens from Sauk County (1909) and the fourth specimen from Pierce County (1911). These are the four specimens noted by Cory (1912) in his work on the Mammals of Illinois and Wisconsin. The data that has been published since this time are scattered and not readily available and there are also a number of specimens that have not been recorded in the literature so it seems advisable to bring together the existing data on the distribution of the species in Wisconsin.

A map showing the distribution of the known records of the least weasel is given in Figure 1. This map shows the distribution of specimens that I have seen, literature records, and reliable observations. The last class was used very sparingly since it was found that most trappers and fur buyers do not distinguish between this species and small individuals of *Mustela erminea*.

In discussing the distribution of this weasel I shall start with the southeastern counties of Wisconsin and work towards the northwest. The first record (Ward, 1907) was a female and is now # 1363 in the Milwaukee Public Museum. This is the only record that I have found for Racine County though there are at least four records for the species a short distance to the south in Illinois (Necker and Hatfield, 1941). The lone record for Jefferson County is based on observations by Irven O. Buss and Arthur Hawkins on January 13, 1937, in the southern edge of the Faville Grove Wildlife Area (S23-T28N-R14W). Here they found tracks which they identified as belonging to this species. Both men are familiar with this weasel.

A specimen from Dodge County was taken at Beaver Dam by Snyder on August 30, 1914 (Univ. Wisc. Zool. Col. No. 11832). In addition, Wayne Truax, Manager of the Horicon Marsh Wildlife Area, reports that at least two least weasels were taken during the muskrat trapping season in the fall of 1946. He saw none in 1947. During the summer of 1948 Harold Mathiak reports that several were seen, apparently a family group, when a stump was pulled in a low area between Horicon and the Horicon Marsh headquarters. One was killed and definitely determined as a least weasel.

Winnebago County is represented by two specimens taken by Clyde Terril on his muskrat marsh between Oshkosh and Omro. These specimens were taken in December and are now numbers 404 and 405 in my collection. A number of others had been taken from the same marsh. William Krenze, a reliable fur farmer who has a muskrat marsh at Omro, states that he has taken the least weasel off and on for a number of years and that they were comparatively abundant during the falls of 1946 and 1947. This statement was made after examining specimens that I had with me at that time. He stated that most of the trappers consider that there are two weasels in this area, the short-tailed weasel (*M. erminea*) and the long-tailed weasel (*M. frenata*). The occasional *M.*

rixosa that is taken is usually thought of as being a young *M. erminea* of a late litter or a "runt" of this species. The general opinion is that the population was comparatively high during the fall of 1947 for the Winnebago County area.

FIG. 1.—Distribution of the least weasel in Wisconsin.

A skull taken from the stomach of a rough-legged hawk by Earl Wright of the Neville Public Museum, Green Bay, Wisconsin, constitutes the lone record for Brown County. The hawk was killed at DePere in 1945. Mr. Wright informs me that this skull was identified by H. H. T. Jackson as being that of a *Mustela rixosa*.

No specimens are known for Waupaca County, but I had a muskrat trapper describe a weasel, that he considered to be unusual, which I am sure was a least weasel. It was taken from west of Freemont during the fall of 1941.

A mounted specimen of least weasel, in possession of William H. Busse of Oxford, Wisconsin, was seen and identified by Robert McCabe and represents the lone record for Marquette County. It was taken at Crooked Lake near the western border of the county. Mr. Busse has had the specimen for a number of years, but was unable to give an exact date for its capture.

Mr. John W. Thompson, Jr., has a specimen which was taken January 9, 1949, near Edgerton, Rock County, Wisconsin, by George Sherman. This is the only record available for Rock County.

There are several records for Dane County, most of them for the vicinity of Madison. Some of these are in collections as follows: Univ. Wisc. Zool. Collection, 1; A. W. Schorger, 1; Univ. of Wisc. Wildlife Mgt. Collection, 2; and Harold Hanson, 1. These have been taken during the last ten years. Specimens from Mazomanie and Roxbury Township, numbers 3281 and 3328 in the Milwaukee Public Museum, are listed as being taken in 1915–16. One skull was taken from a great horned owl pellet at Stoughton (Errington, Hamerstrom, and Hamerstrom 1940) and another skull was found in the pellet of a great horned owl which was collected near McFarland on April 11, 1931 (Nelson, 1934). The latter skull is No. 251114 in the Fish and Wildlife Service collection, U. S. National Museum.

At least nine specimens are known from the southeastern part of Sauk County. These are in various collections as follows: Hanson, Nos. 638, 652, 686, 651, and 653; Milwaukee Public Museum, Nos. 3370 and 4067; Chicago Museum of Natural History, No. 21818; one in the collection of the Univ. of Wisconsin Wildlife Department and one in the Univ. of Wisconsin Zoology collection. Six of these were taken in 1943, two in 1907, and one in 1948.

During the summer of 1948 a female least weasel was taken near Stoddard in Vernon County. This animal was pregnant and contained four embryos. The specimen is in the Univ. of Wisconsin Zool. Collection.

Wm. T. Lambert, a taxidermist at Taylor, Wisconsin, writes that he has two least weasels mounted which were taken during the winter about fifteen or twenty years ago at Springfield, Jackson County. He also states that his dog killed one on February 15, 1948, in the same locality. Mr. Lambert is very familiar with the local fauna and is considered to be a competent naturalist.

The two records for Dunn County are from the notes of Irven O. Buss and are as follows: "Nov. 22, 1941. S23-T28N-R14W. Least weasel tracks were seen in a boggy pasture having scattered hardwoods and alder thickets, about halfway between highway "29" and Gilbert Creek on the Charles Haffelder farms. This weasel was later trapped by Charles Haffelder, Jr. who described it to me. December 20, 1944. S13-R13W-T28N (Island in the Upper Lake Menomin) Helmer M. Mattison found a weasel that had been killed by a red fox. The remains proved to be those of a least weasel when we examined them."

The records for Pierce County include the record by Ward (1911) from Prescott

(Milwaukee Public Museum, No. 2901) and a specimen in the collection of Irven O. Buss. The latter was taken December 23, 1939, at S1-R16W-T27N. This specimen was taken between a railroad right-of-way and an ungrazed spring ditch grown to willow, grass, and goldenrod.

The records shown here and those listed by Necker and Hatfield (1941), Polderboer (1942), Hatt (1940), and Swanson, *et al.* (1945) indicate that the least weasel is probably scattered over most of southern and western Wisconsin and possibly absent from much of the northern part of the state. To date I have found no records or promising reports from the northern part of Wisconsin. Hatt(1940) found no definite records for the adjacent Upper Peninsula or for the northern part of the Lower Peninsula of Michigan.

At the present time there is not enough data to state that the least weasel does not occur in northern Wisconsin or in the Upper Peninsula of Michigan, though this is possible.

The habitat apparently preferred by the least weasel in Wisconsin seems to be high marsh with the ground-water level at or very near the surface during a good part of the year.

Undoubtedly future collecting will extend the known distribution in Wisconsin and it will be interesting to see if the northern area is actually without this interesting weasel or if the lack is merely due to the difficulty in capturing it.

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[Contribution from the Zoological Laboratory, Univ. Wisconsin.]

Div. Ent. and Econ. Zool., Univ. of Minnesota, St. Paul, Minn. Received June 30, 1949.

A HYBRID GIBBON

By M. F. Ashley Montagu

In 1933 Zuckerman listed some nine records of intergeneric crosses in the Primates. In each case one of the parents was a macaque. The other parent was a baboon in six cases, a guenon in two cases, and a mangabey in another. He also listed six interspecific crosses between cercopitheques, one interspecific cross between semnopitheques, one between capuchins, and one between marmosets, and pointed out that interspecific crosses between lemurs had been recorded many times.

Recently I secured records of an additional four intergeneric and twenty "interspecific" crosses in primates. The records of thirteen of these crosses were obtained from the register books of the Zoological Society of Philadelphia and eleven from the list of the Zoological Society of London. The individual records are listed below. From the register books of the Zoological Society of Philadelphia are the following:

INTERGENERIC CROSSES

Macacus rhesus ♂ x *Papio hamadryas* ♀	♀ born 29 Oct., 1913; died 24 Mar., 1914.
Macacus irus ♂ x *Cercocebus fuliginosus* ♀	? born 22 Sept., 1888; died 29 Dec., 1888.
Macacus irus ♂ x *Cynopithecus niger* ♀	♀ born 7 May, 1912; lived 7 hours.
Macacus nemestrina ♀ x *Cercocebus fuliginosus* ♂	♂ born 8 June, 1933; died 22 Apr., 1935.

INTERSPECIFIC CROSSES

Macacus rhesus x *Macacus irus*	? born 23 Feb., 1887; died 26 Feb., 1887.
Macacus rhesus x *Macacus irus*	? born 2 May, 1894; died 6 May, 1894.
Macacus irus ♂ x *Macacus nemestrina* ♀	♂ born 19 Nov., 1886; died 14 July, 1890.
Macacus silenus ♂ x *Macacus nemestrina* ♀	♂ born 26 Jan., 1900; died 31 Aug., 1900.
Cercocebus fuliginosus ♀ x *Cercocebus aethiops* ♂	♀ born 24 Apr., 1935; died 26 Apr., 1935.
Cercocebus fuliginosus ♂ x *Cercocebus aethiops* ♀	? born 31 Aug., 1934; died 2 Sept., 1934.
Cercocebus aethiops ♀ x *Cercocebus mitas* ♂	? born 11 Feb., 1911; died 11 Feb., 1911.
	♀ born 22 Dec., 1906; died 22 Dec., 1906.
Papio langheldi ♂ x *Papio sphinx* ♀	♀ born 22 Dec., 1906; died 22 Dec., 1906.
Lemur macaco ♀ x *Lemur mongoz* ♂	♂ born 22 May, 1911; died 26 May 1911.

From the list of the Zoological Society of London (1827–1927, Mammals, vol. 1) are the following:

INTERGENERIC CROSS

Macacus irus ♂ x *Mandrillus* ♀, 13 October, 1878.

INTERSPECIFIC CROSSES

Macacus irus x *Macacus mulatta*, 13 July, 1882.
Macacus irus ♂ x *Macacus mulatta* ♀, 21 March, 1889.
Macacus irus ♂ x *Macacus mulatta* ♀, 27 April, 1906.
Macacus irus x *Macacus nemestrina*, in or before 1860.

Macacus irus ♂ x *Macacus nemestrina* ♀, 1 March 1906.
Macacus mulatta x *Macacus radiata* born 8 Feb., 1846; died 19 May, 1847.
Lemur macaco ♂ x *Lemur fulvus* ♀ Four hybrids between 1899–1913.

A search in the register books of most zoological gardens in the United States and those of other countries would undoubtedly reveal records of numerous other crosses between primates. It would appear highly probable that crossing is possible between many more species and possibly more genera of primates than we have records for at present.

Direct evidence of crossing between different genera, or species, of anthropoids has not hitherto been reported in the scientific literature, though the appearance of certain animals has suggested to some students the possibility of a chimpanzee-gorilla cross (Yerkes and Yerkes, 1929).

In the present paper I wish to report a cross between two gibbons usually classified as separate species. The cross occurred in the National Zoological Park at Washington, D. C., and is between a female *Hylobates agilis* and a male described as *Hylobates lar pileatus*.

The female has a pelage which is a rich, dark calf brown, with a plum or maroon tinge, except in the lumbar region in which it is light brown. The exposed skin is everywhere dark brown. The description answers to *Hylobates agilis* of Sumatra, and the animal is known to have come from there.

The male has a pelage which is totally black, except for a circumfacial and narrow supraorbital band of white hair, bilateral white temporal bands, white hairs with a few black hairs on fingers and toes, and a striking band of white hair about two and a half inches long by three-quarters of an inch broad on each side of the scrotum, forming a "V" with its apex directed anteriorly. The skin on all visible surfaces, face, hands, and feet, is entirely black. The nails are also black. This is not quite the typical description of *Hylobates lar* even in its black phase, and hence, I suppose, the addition of the subspecific name *pileatus*. The characters of this animal appear to resemble more closely those of *Hylobates hoolock* than they do any other gibbon. The animal was purchased from a dealer at Singapore. Its origin is otherwise unknown.

The female was received at the United States National Zoological Park, Washington, D. C., on 12 May 1938, the male was received on 27 May 1938. On 20 October 1944 the female gave birth to a daughter, who was promptly named "Barbara" by her keepers. Barbara was born pink and hairless, and since her mother appeared to be incapable of caring for her (Montagu, 1946), Barbara was removed from her mother and raised by hand. When seen by the writer on 6 January 1948 Barbara and her parents were in excellent condition. Barbara was then some three years and three months of age.

Barbara's pelage is very different from that of her parents, and it is quite likely that it will undergo change with age. The following features may be noted: head hair is black; there is a supraorbital band of gray hair, with a similar shade of gray upon the sides of the face and head, and sparse gray hairs under the chin. The base of the nose and the upper and lower lips have a sparse growth of gray hair. The upper back is dominantly black, shot through with

gray hairs; the lower back is dominantly gray, shot through with black hair. The upper arm is dark gray, the lower arm is lighter gray. The lower extremities are gray, and the dorsal surfaces of the hands, fingers, feet, and toes are covered with gray hair. All exposed skin surfaces, including the nails, and ischial callosities, are as black as those of the father. The color of the iris is the same in all three animals, namely, dark brown.

Careful examination of Barbara, at a distance no more than is represented by the thickness of a sheet of plate glass, failed to reveal a single hair the color of her mother's. Barbara's pelage is dominantly dark gray, and her skin is black like her father's, but unlike her mother's dark brown skin.

This cross once again raises the question of species in the primates. The habitats of *Hylobates agilis* (Sumatra) and *Hylobates hoolock* (Upper Assam, Aracan, Yunan) are discontinuous. We are therefore concerned here with two geographically separated groups.

It seems evident that *Hylobates agilis* and *Hylobates hoolock* represent geographic races of a single polytypic species. That is to say, we are here dealing with geographic variants of a single species, a species being understood to be a group of actually, or potentially, interbreeding natural populations which is reproductively isolated from other such groups. Geographic separation has here produced reproductive isolation, and hence geographic variation.

Some species are monotypic, that is to say, there are species in which all the members closely resemble one another. Monotypic species generally occupy a limited range, and since there is an absence of geographic barriers there is no opportunity for reproductive isolation and hence geographic variation. The gibbons are obviously not monotypic, they are clearly polytypic, and the value of the case of crossing here described is—not that such a cross was in the least unsuspected as possible—that it makes the acceptance of such a viewpoint easier.

Schultz (1933) has described nine species, and Elliot (1913) as many as thirteen species, of gibbons. It is an open question whether we are not here dealing with geographic races of a single polytypic species, or possibly two species. The species of gibbons described by most authors are, most likely, no more than geographically, and therefore reproductively, isolated groups of the same species. Owing to their reproductive isolation superficial differences have developed which earlier systematists used as a basis for separating groups which, specifically at least, belong together. The classification of the gibbons, as of all other primates, requires reinvestigation in the light of the newer systematics.

Perhaps in no other mammalian group have taxonomists enjoyed such an orgy of "splitting" as in the Order of Primates. As many as 600 species of living primates, not counting synonyms, have been recognized by D. G. Elliot in his A REVIEW OF THE PRIMATES. There can be little doubt that the true number is considerably less. The primates as a whole exhibit a high degree of morphological variability. This fact, taken together with a mid-nineteenth century species concept which was for the most part based on the study of skins and skeletons in museums, led to a regular orgy of classificatory speciation. Differences rather than likenessess were sought, and more and more refined morphological dis-

tinctions between groups were recognized. The excesses thus committed led to the creation of numerous species in almost every animal group. Today, careful field studies and analyses by biologists, with a fuller understanding of the nature of variation than the nineteenth century taxonomist possessed, have been responsible for something of a reversal of this tendency.

Linnaeus' rather static morphological concept of a species underwent a considerable enlargement in the nineteenth century, as a consequence of the publication of Darwin's ORIGIN OF SPECIES (1859). It is, however, only recently that, with the development of the science of genetics and the increase in our knowledge of the processes of speciation, we have been able to achieve a biologically sound concept of the nature of a species.

To the modern biologist, a species is a more or less temporary eddy in the stream of evolution. A species is not a fixed, static, sharply delimitable group, but a more or less definable result of the process of evolution. This process is to some extent observable in the resulting variation presented by geographically separated potentially reproductive groups. Such groups were formerly described as species, and there can be little doubt that many groups of primates which are today listed as species, fall into this category.

It need hardly be reiterated that the ability of members of two groups of primates to interbreed does not thereby make them members of the same species. The intergeneric crosses cited in Zuckerman's list, and in the present paper, are sufficient evidence of the ability of morphologically well differentiated primates to interbreed. The purpose of the present paper is to report a case of crossing between alleged species of gibbon, and in the light of that cross to raise the question whether the morphological differences existing between most described species of gibbons really merit the rank of species differences.

I am much indebted to the Viking Fund, New York, for a grant which enabled me to study the gibbons reported in this paper. To Dr. W. A. Mann, Director of the National Zoological Park, Washington, D. C., I owe many thanks for permission to study these animals, and to Mr. Fred Ulmer of the Philadelphia Zoo I am indebted for his helpful interest in making the register books of the Zoo available to me.

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MOVEMENTS AND SURVIVAL OF RATS IN HAWAII

By H. J. Spencer and David E. Davis

Through Presidential Proclamation (May 1933 and amended May 1944) funds obtained from processing taxes collected on Hawaiian-grown sugar were allocated for the betterment of agriculture in the Territory of Hawaii. As a part of this program a rat control project designed to abate rat-borne diseases and economic losses was established in December, 1935, and continued through June 1938. The project was directed by the Hawaii Agricultural Experiment Station with personnel loaned by the Bureau of Biological Survey (now Fish and Wildlife Service).

From investigations in 1938, it was possible to learn something of the movements and survival of the rats by releasing marked individuals. In this paper, the data obtained are compiled and analyzed.

The study was conducted in a field located in a semi-mountainous (gentle slope) section along the northern (windward) side of the island of Oahu. The land (Pl. I, upper) was uncultivated and overgrown (Pl. I, lower) with a number of plants, the principal species being lantana, guava (*Psidium guava*), and the creeping plant (*Commelina nudiflora* Linn.). The climate is equable with sufficient rainfall to sustain an abundance of both plant and animal life. The soil is basically of volcanic origin consisting of basaltic lava which has disintegrated into lava, tufa, and sedimentary soils. The study plot was not subject to interference by man.

The method used in trapping, marking, and releasing the rats consisted of: (1) Establishment of single cage traps at intervals of 100 feet on rows which transected the plot at intervals of 150 feet; (2) etherizing and marking the rats with an ear-lobe and hole-punch system; (3) release following recovery from ether at point of capture. Plate I, lower, shows the type of trap and the box for etherizing. This work was conducted from February to April 1938.

The principal species studied was the roof rat, *Rattus rattus*, which included the varieties known as *R. r. alexandrinus* and *R. r. rattus*. Since no difference in movements or survival was noticeable, the records for the two varieties are analyzed together. In addition, a number of Hawaiian rats (*R. hawaiensis*) and brown rats (*R. norvegicus*) were captured and released.

The population of the 47-acre experimental area was about 475 roof rats. During the experiment, 420 roof rats were caught. In exhaustive trapping at the close of the experiment, 34 additional unmarked roof rats and only 57 of the originally marked stock, totaling 91 rats, were caught. Calculations of population by the recapture ratio method (Petersen, Rept. Danish Biol. Sta. for 1895. 6: 1–48, 1896) gave 494 roof rats, which is a satisfactory agreement.

Movements.—The distances at which rats were recaptured are summarized in Table 1. These distances were measured from the place of penultimate capture, not from the place of original capture. Thus a rat which was first caught at A, then caught 30 feet away at B, and then caught again at A, would be recorded as having made two movements of 30 feet; not as having made one movement

of 30 feet and one of zero feet. Because of small numbers, *R. hawaiensis* and *R. norvegicus* are not divided into sex or age categories.

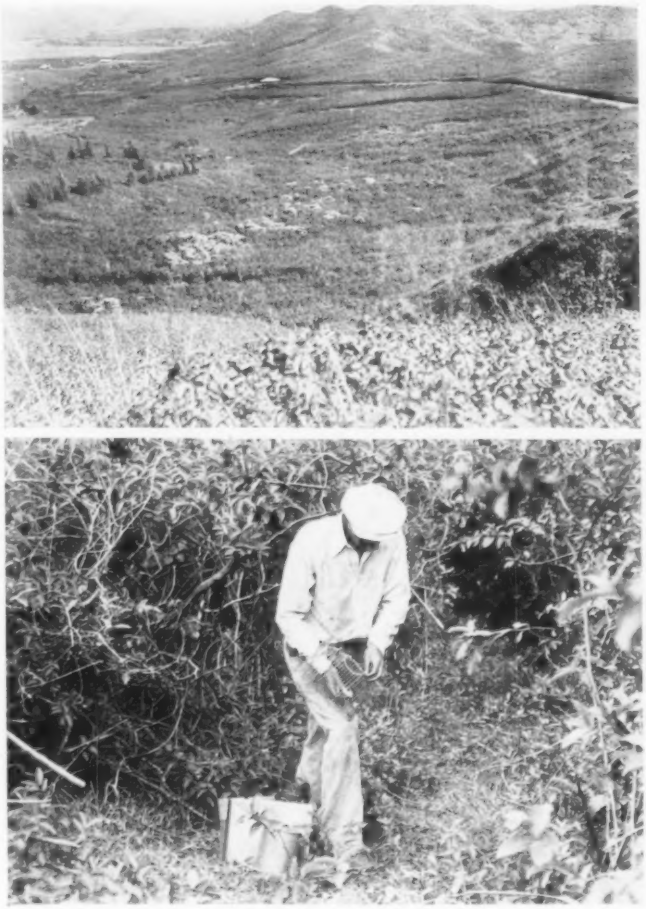

PLATE I

Upper: Experimental plot on Oahu

Lower: Thick brush on experimental plot, and trap and etherizing box

It is apparent that the rats tended to remain within an area with a diameter of about 200 feet. Females of *R. rattus* may have more restricted movements than males have since 77 per cent of the females were recaptured within 200 feet. However, the difference has little statistical significance ($P = 0.1$). *R.*

TABLE 1.—*Distances of recaptures of rats*

DISTANCE IN FEET	RATTUS RATTUS			RATTUS HAWAIENSIS	RATTUS NORVEGICUS
	Adult Male	Adult Female	Young		
0	28	25	23	53	7
1–99	9	8	3	1	4
100–199	34	30	12	29	4
200–299	9	2	6	4	4
300–399	4	4	4	4	2
400–499	2	2	1	3	1
500–599	4	1			2
600–699		2	1	2	1
700–799	3	1			1
800–899		1	1	1	1
900–999	1		1	1	1
1000–1099				1	1
1100–1199	5	1	2		2
1200–1299	1		1		1
1300–1399	2				
1400–1499	3	1			
1500–1999	2	1		3	
2000–2999	1	3			
Totals	108	82	45	102	32

TABLE 2.—*Disappearance of rats*

DAYS	RATTUS RATTUS			RATTUS HAWAIENSIS	RATTUS NORVEGICUS
	Adult Males	Adult Females	Young		
1–9	76	60	38	54	14
10–19	50	47	24	27	10
20–29	43	38	22	17	8
30–39	33	31	17	13	6
40–49	22	23	13	6	6
50–59	16	16	7	4	5
60–69	10	13	6	4	3
70–79	8	6	5	2	
80+			1	1	
Disappearance time in days (observed) — 5 per cent	103	122	104	66	134
Disappearance time in days (observed) — 50 per cent	21	33	22	19	35
Survival time in days (calculated) — 5 per cent	122	144	123	78	158
Survival time in days (calculated) — 50 per cent	25	39	26	22	42

hawaiensis, the smallest species, has more restricted movements than does *R. norvegicus*, the largest species.

An analysis of these recaptures, according to time since original capture, did not show any increase of movements with longer periods of time since first

release. The extensive movements (over 1000 feet) shown in Table 1 occurred just as frequently within a week of first release as within ten weeks.

Disappearance of rats.—The duration of records for the rats are given in Table 2. These figures were obtained by considering the known life of the recaptured rats in the following manner. Of the adult male *R. rattus* marked and released, only 76 were recaptured at any time. Of these 76, twenty-six were not captured after the ninth day, leaving 50 known to be alive on that day. Similarly, of these 50, seven were not captured after the nineteenth day, leaving 43 known to be alive at that time. It is obvious that these data do not represent the survival of the rats, but merely the rate of disappearance. The rats were still alive when last trapped and lived for an unknown period of time after last capture. Davis (Ecol., 29: 437, 1948), however, found that the disappearance rate was roughly 85 per cent of the true mortality rate. Hence, a satisfactory approximation to the survival time can be obtained by dividing the disappearance time by .85. These results are given as survival times in Table 2. It must be emphasized that these figures are only approximations.

Although the disappearance figures give only a rough estimate of the survival time, the figures can be used to compare sexes, ages, and species. It is evident that adult females of *R. rattus* live longer than do adult males, and that *R. hawaiensis* has a relatively short life and *R. norvegicus* a relatively long one.

The extremely short disappearance times are perplexing. These results suggest that half the rats have died by the end of about a month and that only 5 per cent are left at the end of 3–5 months. Several explanations are possible. This high disappearance rate may be due to etherization, but experience with releasing etherized rats in Baltimore (Calhoun) indicates rare mortality. The high rate may be due to the decline in the population from about 475 rats to less than 100, or to difficulties in retrapping the rats more than once, or to predation by mongooses, hawks, etc. The data on disappearance are presented because they show: (1) disappearance rates proportional to the size of the species of rat, and (2) disappearance rate of male roof rats higher than that of females.

Summary.—Movements of three species of rats (*Rattus rattus*, *R. hawaiensis*, and *R. norvegicus*) were studied in a brushy field on the island of Oahu, Hawaii. All species had a limited home range. The data also show a survival time of only a few months, which may be artificially short due to local factors.

Fish and Wildlife Service, Gainesville, Florida, and Rodent Ecology Project, The Johns Hopkins School of Hygiene and Public Health. Received May 16, 1949.

SOIL TEMPERATURES, WEATHER CONDITIONS, AND EMERGENCE OF GROUND SQUIRRELS FROM HIBERNATION

By Otis Wade

Results of studies on the hibernation of ground squirrels in the region of Lincoln, Nebraska, over a series of years, show that the time of emergence from winter sleep, under natural conditions, varies widely. Dates as early as the second week of February and as late as the first week of April are recorded, with March showing the greatest number. These wide variations in time are not explainable entirely by any suggested reasons in the literature known to the author. The purpose of this report is to present certain data pertinent to this question, and which point to a factor of apparent significance.

General considerations.—The time of emergence of ground squirrels from hibernation is associated with several environmental conditions and it is probable that it is dependent on some one or more of them (Johnson, 1931; Wade, 1930; and others). An explanation commonly advanced is the "warming up of the soil" sufficient to arouse the squirrels from their torpid state and to stimulate them to dig out, as they have to do, and begin seasonal activities above ground.

There is, of course, the usually accepted view of the inherited cyclic hibernation behavior (Wade, 1930, 1948) to be considered even though some ground squirrels in regions with mild winters do not hibernate, at least in the manner of the northern species. The antelope squirrels (*Ammospermophilus*) do not (Howell, 1938:29), and perhaps there are others. In general, species of *Citellus* do, and much of their range is in regions where cold winters are the rule.

The studies made here on the thirteen-lined ground squirrel, *Citellus tridecemlineatus*, and the Franklin squirrel, *C. franklinii*, indicate that there are factors other than temperature which exert a controlling influence. Extensive observations in this region on hibernating ground squirrels under controlled conditions, and in nature, show that they will, as a rule, awaken from deep sleep at irregular and sometimes frequent intervals and move about (Johnson, 1931; Wade, 1930). That they may do so when the soil is not "warmed up" and that they do not then appear above ground has been determined. It is also known that at a 20-inch depth, a depth great enough to insure safety from freezing (Wade, unpublished data), the soil usually has not been warm, in the sense that the squirrels were actually warmed in their nests to the extent of arousing them from lethargy, when they actually did emerge. Rather, the temperature level was very favorable to maintaining the torpid state characteristic of these squirrels in hibernation, as commonly noted under controlled experiments (Wade, 1930).

Present investigation.—The data used here, covering the records of ten seasons, show that the soil temperatures on emergence dates at the above depth have ranged between 7.5° C. (45.5° F.) and 14° C. (57° F). Since these closely approximate favorable hibernating temperatures it seems evident that the temperature of the soil at the hibernating level is not the controlling factor in the normal awakening and emergence of the squirrels.

The ground squirrels of this region have the habit of closing the entrances

to their dens with earth when they go in to sleep or to escape pursuing enemies. It is assumed that this is a protective device against intruders rather than against the elements. When they go into the quarters they have prepared for hibernation they effectually close any tunnels leading to these from above ground with a considerable amount of earth firmly packed in. Thus, when they wish to get out, considerable digging is necessary; in fact ground squirrels, when they emerge from hibernation, often do not reopen the old passageways, but dig out through the soil in the most direct way, opening up a fresh exit.

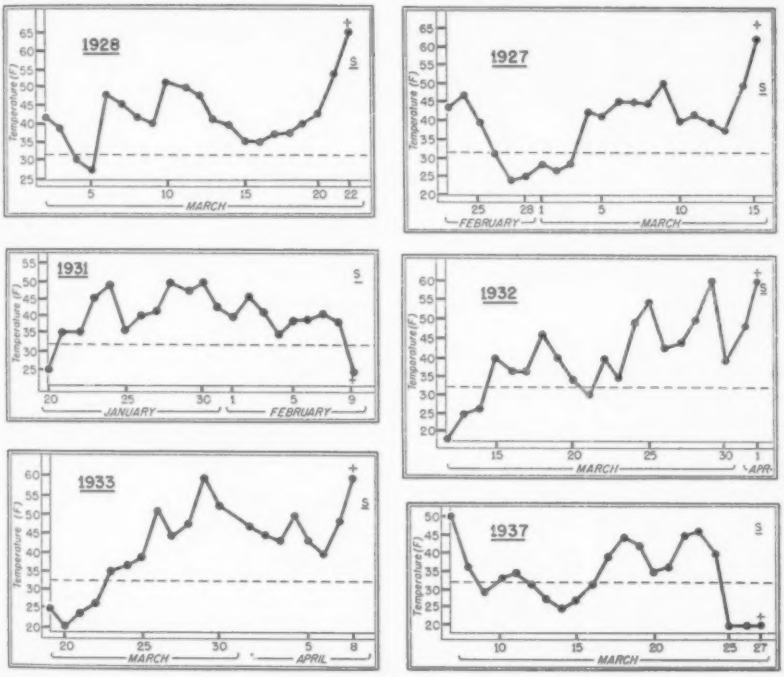

FIG. 1.—Mean atmospheric temperatures (F.) for twenty-one days preceding emergence dates for six different years. Cross indicates date of emergence; S indicates soil temperature at twenty-inch depth on same day.

In the winters the soil is usually frozen, often down an appreciable distance. Should a squirrel try to reach the surface at this time, the frozen earth would present a real barrier and make digging through almost impossible, especially after some time in the torpid state when the animal has become thin and weakened from fasting. There is evidence that these squirrels do often try to reach the surface during a waking period and do sometimes succeed, following a period of thaw when the soil is not frozen, even in midwinter. This strange occurrence was observed here in January, 1939, when, following about two weeks of very warm weather with complete thawing of the frozen soil, squirrels appeared above ground on January 12. Lowered temperatures followed almost

at once and continued into March when, after several weeks of rising temperatures, the squirrels made their "regular" spring emergence on March 19.

In the accompanying graphs (Figs. 1 and 2) the daily mean atmospheric temperatures are shown for three weeks preceding the recorded dates for the emer-

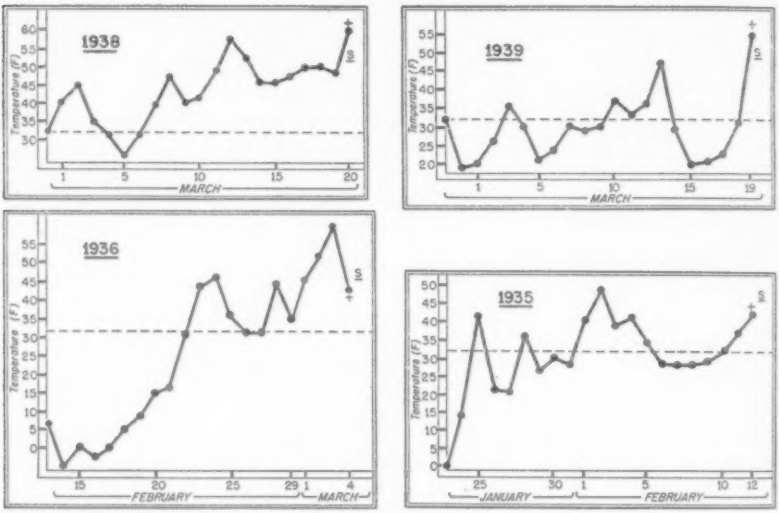

FIG. 2.—Mean atmospheric temperatures (F.) for twenty-one days preceding emergence dates for four different years. Cross indicates date of emergence; S indicates soil temperature at twenty-inch depth on same day.

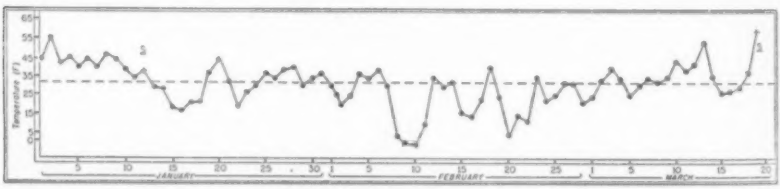

FIG. 3.—Mean atmospheric temperature (F.), January 1 to March 19, 1939. Cross indicates emergence date; S indicates soil temperature at twenty-inch depth on same day.

gence of the squirrels each spring. This time-span is used because it covers a period during which temperature rises required for the necessary thawing occur. The seasonal records of ten different years are used to show how the thawing and loosening of the soil correlate fairly closely with the spring ground squirrel emergence. At the end of each curve a cross (+) indicates the recorded date of emergence. Also on that day a letter "S" is placed to show the soil temperature at a depth of 20 inches. It should be noted that the emergence dates recorded are not necessarily exact, but are the days the writer, of his own knowledge, had evidence that squirrels were out. Some may have appeared one or more days earlier, but careful checking with various interested persons whose ob-

servations could be relied on indicated no discrepancies great enough to be significant.

The ten years the writer has used in the graph were selected solely because the records of them were complete and verifiable on the points presented herein as having a bearing on the question of time emergence.

In Figures 1 and 2 the curve for each year shows that temperatures sufficiently high to insure effective thawing were maintained for ten or more days preceding the emergence date. A dotted line has been established with each yearly curve at approximately the level of 32° F. Eight of the years show appreciable rises in temperature above this level for ten or more days. Only two years, 1939 and 1935, do not conform as strikingly to this pattern.

A brief review of the unusual case of 1939, previously mentioned, when squirrels came out in midwinter for a day or two and again in March, will emphasize the suggestion of a frozen soil barrier operating to prevent more frequent and/or earlier emergences from hibernation (Fig. 3).

The last days of December, 1938, saw the onset of warm weather reaching high temperatures for this region the first few days in 1939. On January 2, 1939, the mean temperature was 56° F., and mean temperatures of 40° or above were maintained until January 10, with complete thawing of the soil. Ground squirrels were seen above ground on January 12. The atmospheric temperature that day was 37°, while a reading of the soil temperature 20 inches deep showed 46.6° F. On January 13 the temperature above ground had dropped to 28°, and on January 16 it was 17° F. A brief rise followed, reaching 44°, January 20, and then there was an almost immediate drop to freezing the next day. From that point to early March the temperature remained rather uniformly below freezing with subzero levels being reached. On March 5 rising temperatures and thawing appeared and continued until the second emergence on March 19.

Conclusions.—The conclusions are that frozen soil presents a barrier through which ground squirrels cannot dig their way, thereby holding them imprisoned until sufficient thawing and loosening of the soil make digging out possible. Since these conditions vary widely with the years in this region, and are correlated with the annual spring emergence dates, it is reasonable to assign to this factor great importance in any explanation of the fact that ground squirrel emergence dates do vary so widely.

Acknowledgments.—Material assistance was received from the University of Nebraska Research Council through a grant in aid.

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[Studies from the Department of Zoology, University of Nebraska, No. 244]

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A COMPARATIVE STUDY OF LIPIDS IN ARCTIC MARINE MAMMALS

By Charles G. Wilber and X. J. Musacchia

It has been assumed for a long time that fat plays an important role in the economy of Arctic mammals. This assumption has been supported by references to the large amounts of subcutaneous fat found in the marine mammals of the Arctic.

A review of the literature shows that practically no information has been published dealing with fat metabolism in or fat content of the mammals of the North.

The usual lipids that are considered in any study of fat metabolism are total fatty acids, phospholipids, total cholesterol, and sometimes free and ester cholesterol. The ratio of these lipids, one to another, in any tissue is of basic importance. All studies of fat metabolism are based on a comparison of experimental tissues with normal and "consequently the determination of normal values is fundamental" (Bloor, 1943).

Since there are no normal values in the literature for lipids from northern marine mammals, it was necessary to establish such values.

Material and methods.—The following species were examined: the polar bear, *Thalarctos maritimus;* walrus, *Odobaenus obesus;* ringed seal, *Phoca hispida.* The nomenclature is taken from Preble (1908).

Tissues were prepared for analysis by grinding with sand (Bloor, 1943). Ordinarily only one gram of a given tissue was used. Extraction of the lipids was done according to Bloor's (1929) method. Two samples of polar bear liver were quite large, around 30 grams each; the extraction was done by refluxing in hot alcohol (Bloor, 1943).

Total fatty acids were estimated, using the method of Bloor as modified by Snell (1937). Lipid phosphorus was estimated by a modified Youngburg technique (1930); from these values, phospholipid was calculated as lecithin. Measurements of cholesterol were based on methods developed by Bloor (1916).

The following tissues were analyzed: polar bear liver and kidney; walrus heart and liver; seal blood, liver, and kidney. The seal blood was obtained directly from the ventricle. Analytical procedures for blood were the same as for solid tissues.

Table 1 shows the lipid values for the polar bear liver and kidney. The amounts of lipids in the walrus heart and liver are shown in Table 2, and those in whole blood, liver, and kidneys of the seal are summarized in Table 3, which shows the mean values for fatty acids, cholesterol, lipid phosphorous, and phospholipid.

Discussion.—On examining the results of analyses of the polar bear liver, one is struck by the high fatty acid content, 9.8 per cent of fresh tissue. An exhaustive search of the literature reveals no other data on the liver lipids of species closely related to the polar bear. In the human liver, total fatty acids amount to no more than about 4 per cent wet weight. It is obvious that the amount of

TABLE 1.—*Amounts of lipids in the liver and kidneys of the polar bear. All values are in per cent fresh tissue*

LIPID	TISSUE	SPECIMEN A	SPECIMEN B	MEAN
Fatty acid	Liver	8.82	10.75	9.78
	Kidney	3.4	1.45	2.42
Cholesterol	Liver	0.27	0.48	0.38
	Kidney	0.52	0.36	0.44
Lipid phosphorus	Liver	0.11	0.107	0.11
	Kidney	0.03	0.12	0.075
Phospholipid	Liver	2.9	2.68	2.79
	Kidney	0.75	3.01	1.88

TABLE 2.—*Amounts of lipids in the liver and heart of the walrus. All values are in per cent fresh tissue*

LIPID	TISSUE	SPECIMEN A	SPECIMEN B	SPECIMEN C	MEAN
Fatty acid	Liver	4.30	3.90	4.45	4.21
	Heart	2.35	1.60		1.97
Cholesterol	Liver	0.26	0.24	0.29	0.26
	Heart	0.14	0.14		0.14
Lipid phosphorus	Liver	0.13	0.10	0.12	0.13
	Heart	0.067	0.047		0.57
Phospholipid	Liver	3.25	2.50	3.05	3.6
	Heart	1.68	1.18		1.43

TABLE 3.—*Amounts of lipids in the liver, kidneys, and whole blood of the seal. Values for solid tissues are in per cent wet weight; values for whole blood are in mg. per 100 cc. of blood*

LIPID	TISSUE	SPECIMEN				MEAN
		A1	A2	A3	A4	
Fatty acid	Blood	833.3	711.0	1280.0	1000.0	956.0
	Liver	5.0	4.5	4.5	6.5	5.1
	Kidney	3.8	4.1	3.0	4.0	3.7
Cholesterol	Blood	158.0	207.0	181.0	183.8	175.2
	Liver	0.48	0.5	0.36	0.41	0.44
	Kidney	0.47	0.56	0.38	0.53	0.48
Lipid phosphorus	Blood	28.8	23.5	32.0	32.9	29.3
	Liver	0.27	0.4	0.35	0.26	0.32
	Kidney	0.12	0.21	0.23	0.15	0.18
Phospholipid	Blood	706.0	587.5	800.0	822.0	728.8
	Liver	6.7	10.0	8.75	6.5	7.99
	Kidney	2.9	5.4	5.7	3.85	4.46

fatty acids in the polar bear is of a different order of magnitude than the values for man.

Phospholipids in the liver of the bear average 2.79 per cent. In man, the liver contains about 1.7 per cent phospholipid; in the horse, 3.7; the guinea pig, 2.9;

rat, 2.9. A comparison of these values indicates that the level of fat metabolism in the bears taken was not unduly high. The animals were shot during the summer months and hence it may be that a high rate of fat turnover was not essential for the over-all well-being of the beast at that time. Cholesterol in the bear liver, 0.38 per cent, shows nothing unusual.

It is fairly clear that the liver of the polar bear is not peculiar in its lipid content, with the possible exception of the extremely high total fatty acids. This latter fact suggests that further detailed analyses of fatty acids should be made. It is essential that iodine numbers and like values be recorded for the liver lipids of the bear. This is particularly true in view of the repeated reports of toxicity of polar bear livers. Detailed analyses of the polar bear liver oils along the lines of Hilditch's (1947) work are indicated in an attempt to throw some light on the problem of "poisonous" bear livers and on the general mechanism of fat usage in this typically Arctic mammal.

The polar bear kidneys show a fairly routine amount of fatty acids: mean of 2.42 per cent wet weight of tissue. In the normal human kidney there is about 2.06 per cent fatty acids. In the bear, there is no increase in kidney fatty acids paralleling the large amount in the liver. Cholesterol in the kidneys shows nothing unusual.

The mean phospholipid values for bear kidneys, 1.88 per cent, are low as compared with similar values for the horse, 2.6 per cent, guinea pig, 2.8, and rat, 2.9. By reference to Table 1, however, it is clear that one bear had an extremely low phospholipid value, 0.75 per cent; whereas the other had a value of 3.01 per cent. The mean can have little significance in view of the small sample and wide variations. The mean does indicate however that nothing exceptional should be expected in regard to phospholipids in the polar bear kidneys.

Bloor (1936) gives the following lipid values for the heart of the sea lion (per cent dry weight): phospholipid, 5.6; cholesterol, 0.4; phospholipid/cholesterol, 14. In the present work, two walrus hearts were analyzed and a mean of 1.97 per cent wet weight of fatty acids was found. Phospholipid amounts to 1.43 per cent, and cholesterol, 0.14 (Table 2). These values are on the basis of wet weight of tissue and, thus, do not appear essentially different from Bloor's values for the sea lion. The ratio of phospholipid/cholesterol for the walrus heart is 10.2, which is practically identical with the same ratio for human heart. It is close to the ratio, 14, for the sea lion and the dog. The average ratio for twelve different mammals is 15 (Bloor, 1943). The present results indicate that in the walrus heart there is less than the average amount of phospholipid in relation to cholesterol. In fact the P/C ratio is much closer to the average for cold-blooded vertebrates, 8, than it is to the mammalian average of 15.

The mean value of fatty acids for the walrus liver is 4.21 per cent wet weight; total lipids equal about 4.47 per cent. This latter value is higher than that for the liver of the Antarctic blue whale, 3.5 per cent (Klem, 1935), but slightly lower than that for the liver of *Phocaena communis*, 5.0 per cent (Lovern, 1934). Recent analyses of the total oil in the liver of Dall porpoises gives a range of mean values from 3.76 to 4.26 per cent (Scheffer, 1949). If the total oil is equiv-

alent to total lipids (the author does not give details of analytical methods), it is clear that the liver of the walrus and of the Dall porpoise are almost identical in lipid composition.

In the porpoise, *Phocaena*, about one-third of the total fat of the liver is unsaponifiable material (Lovern, 1934), which is mainly cholesterol. Consequently, about 1.5 per cent of the fresh liver tissue in the porpoise is cholesterol. This is much higher than the value of 0.26 per cent for the walrus.

Phospholipid in the walrus liver is about 2.6 per cent of fresh tissue (Table 2). This value is close to that for the horse, 3.7, and is much higher than that for adult human liver, 1.8 per cent (Bloor, 1943).

Table 3 shows that in the seal the whole blood contains an unusually high amount of fatty acids, 956 mg. per 100 cc. Unfortunately serum values are not available at this time. The mean phospholipid value of 728.8 mg. per 100 cc. is also high as compared with other mammals. On the other hand the mean cholesterol value of 175 mg. per 100 cc. is within the range of values usually encountered in the blood of mammals.

The common dog has the following lipid values in mg. per 100 cc. of whole blood: total fatty acids, 520; phospholipids, 330; cholesterol, 170; fatty acids/phospholipids, 1.58; phospholipids/cholesterol, 1.9 (Bloor, 1943). The latter ratios for the seal blood are, respectively, 1.3 and 4.1. These ratios indicate that there is an extremely high amount of phospholipid in relation to cholesterol in the seal blood. The fatty acids are also high in relation to cholesterol since the fatty acid/phospholipid ratio is close to that of the dog. This elevated phospholipid might be interpreted as indicative of a high rate of fat metabolism. However, the blood samples are all from seals that had been shot. It might be that the severe shock brought about a sudden increase in blood phospholipids. Such an increase would have to occur very rapidly since all the seals were wounded thru the back of the neck, a process which severs the cord and brings about almost instantaneous death.

Fatty acids in the liver of the seal run to about 5.1 per cent wet weight. These values are much lower than those in the polar bear. Total lipid averages 5.5 per cent. This value is close to that for the whale liver, 6 per cent (Tsujimoto and Kimura, 1928), but is higher than the values for liver oils in the Dall porpoise (Scheffer, 1949). The cholesterol value of 0.44 per cent wet weight indicates nothing outstandingly different in the seal liver.

As in the blood, the phospholipid in the liver is quite high, 7.69 per cent wet weight. This value indicates that the level of fat metabolism in the seal is much higher than in most mammals.

In the seal kidneys, the average cholesterol value is 0.48 per cent fresh tissue. This cannot be considered different from the cholesterol content of the liver.

The total fatty acids of the seal kidneys average 3.7 per cent, a value which is not particularly great. On the other hand, the average phospholipid in the seal kidney is about 4.46 per cent wet weight. This value indicates that there is an elevated lipid metabolism in the seal, for in both kidney and liver, high phospholipids are found. The kidneys of such widely different animals as the

dogfish, carp, frog, rat, pigeon, guinea pig, and horse all have kidney phospholipids which fall within the range of 2.6 to 3.3 per cent fresh tissue weight (Javillier, Cremieu, and Hinglais, 1928).

It seems clear from the consistently high phospholipid values in seal blood, liver, and kidneys that this mammal was metabolizing fat at a relatively high rate when taken. Although the shock of shooting must be considered, it seems quite probable that, in *Phoca hispida*, fat metabolism takes place at an extremely high rate.

Before any final conclusions can be drawn, it is essential that more seals be examined, at different times of the year and under different conditions of environment. If at all possible, seals should be captured alive and maintained in the laboratory under controlled conditions for a time before taking the blood. Moreover, carbohydrate analyses should be made to ascertain whether non-lipid metabolism is also unusual.

This latter point is quite essential, especially in view of the preliminary analyses for blood sugar that were made in connection with the present investigation. A few values for seal whole blood are given as follows, all in mg. glucose per 100 cc. of blood: A-12, 102.6; A-18, 64.5; A-22, 60.6. The normal range for human blood glucose is 70 to 120 mg. per 100 cc. The present values for the seal blood fall along the lower edge of the range for man. In the work on the seal, blood was collected in tubes to which fluoride was added to prevent enzymatic breakdown of the sugar before analyses could be made.

Summary.—Analyses for cholesterol, phospholipid, and fatty acids were made on the liver and kidneys of the polar bear and seal. Walrus heart and liver, and seal whole blood, were also analyzed.

The results, presented in tabular form, indicate that there is an unusually high level of fat metabolism in the seal.

The polar bear liver contains a very large amount of fatty acids, but the other lipids are not unusual.

Walrus tissue resembles other marine mammalian tissue.

A discussion of these facts is presented, and future work is suggested.

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Biological Laboratories, St. Louis University, St. Louis 4, Missouri. Received July 11, 1949.

WINTER HABITS AND NUMBERS OF TIMBER WOLVES

BY WM. ROWAN

The record presented herewith was made by Mr. C. Sawyer, Game Inspector (at the time a Forest Ranger), between December 1, 1944, and March 31, 1945, in response to persistent complaints that timber wolves were super-abundant and ravaging the local game supply. The area involved is in the Province of Alberta, Canada, with its eastern boundary some 50–60 miles west of the town of Red Deer and Innisfail, and south of Rocky Mountain House, covering about 38 miles from north to south and 50 from east to west. It lies inside a Provincial forest reserve, occupying approximately Townships 33–38 and Ranges 8–14 W. 5th Mer., in foothill country getting more and more mountainous to the west, and is criss-crossed with registered trap-lines. Numerous small rivers and creeks transect it; named after one of these, it is habitually known as the Clearwater District. The sole inhabitants are rangers, trappers, and a single herder.

The story is perhaps best told in Mr. Sawyer's own words as received in a report this winter (1948–49). He says:

During the period in question, reports of large packs of wolves in the Clearwater district were continually being carried into the office of the Forest Superintendent at Rocky Mountain House.

Mr. Hall, the Forest Superintendent, questioned me each time I was in his office regarding these numbers, and my reply each time was that the numbers were surely exaggerated. These reports were so numerous that it looked as though I was very much in the wrong; therefore I worked out the following plan.

I asked all the trappers and Mr. Winter, a herder, if they would keep an accurate tally of the number of wolves or wolf tracks, the date seen and the direction of travel. This was done with the following results. I collected the data at regular intervals and recorded them on a map similar to the one enclosed (Fig. 1).

The starting points on the map are at two points on trapper McNutt's trap-line. Five tracks were seen on December 19, headed southeast, and three tracks were seen on December 20, headed south. Browning saw eight tracks on December 21, heading south. On January 15, there were eight wolves seen by trapper Miller headed northwest. On January 29, Browning saw four tracks heading northwest. On January 30, Winter saw four tracks heading northwest. On February 5, Sundberg saw four tracks headed north. February 6, Conner

saw four tracks headed northeast. February 15, McDonald saw eight wolves headed southeast. February 19, McNutt saw eight tracks headed south. On February 28, Browning saw eight tracks and caught one wolf out of this pack. The remainder headed in a northwesterly direction. March 6, McNutt saw two tracks headed northwest. March 7, Jameson saw five tracks headed west. March 8, Conner saw seven tracks, and so the circle went. At no time during the remainder of that trapping season were there tracks enough seen to number over seven wolves.

I did not inform the trappers as to my reasons for gathering these figures.

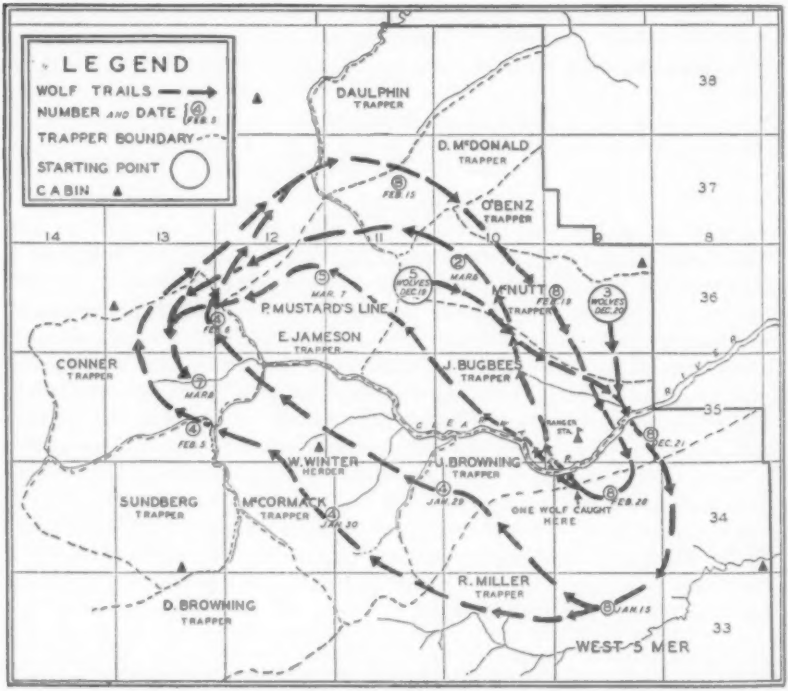

FIG. 1.—Map, showing wolf trails.

I have lost the record of actual dates and have used approximate dates on the sketch map accompanying this statement. The map, however, is accurate and the names are the actual names of the men involved. The records received were more numerous than those herewith submitted (which are samples rather than exact records); J. Bugbees, for example, not here included, reported several appearances of this pack.

The simplicity and ingenuity of this approach to wolf numbers in a restricted locality appears so effective and convincing that it might well be adopted elsewhere. It is questionable if the numbers of any other animal are as persistently exaggerated as those of the timber wolf, still held in awe by Indians, residents, and many trappers themselves, while sportsmen and herdsmen habitually hold extravagant opinions on wolf populations and the damage done by them. The

toll taken by this resident pack of eight animals was not recorded and may conceivably have been heavy, but must at least be far below a local estimate of damage which depends on the supposition that the district is "full of wolves."

Mr. Sawyer records the interesting fact that he has never yet seen a wolf walk. The animals either stand, trot, or run, an observation corroborated by the trappers themselves.

Department of Zoology, University of Alberta, Edmonton, Alberta. Received August 8, 1949.

TIMBER WOLF MOVEMENTS ON SIBLEY PENINSULA, ONTARIO

By A. DE VOS

Much has been published already about the depredations of the wolf, but little detailed information is available about the movements of wolves in restricted areas. Information on timber wolf movements can be found in Young and Goldman's book (1944, pp. 81–84) and more specific information in papers of Olson (1938), Cowan (1947), Murie (1945), and Stebler (1944). When reading the publications of most of these authors, one gets the impression that wolves use runways or hunting routes which they travel rather regularly. These runways are described by some of them to cover a circuit which consists of an irregular circle, the diameter of which may vary between 20 and 60 miles. The extent of the circuit seems to depend on the amount of food available. Generally short detours or scouting courses, which are apparently deviations used in the search of prey lead away from the main runway. The hunting routes are usually travelled by packs of wolves, but occasionally by single ones. Packs may travel up to forty miles a day along such routes. The circuits do not appear to remain the same during the different seasons, but seem to be considerably shortened during the denning period.

The purpose of this paper is to give information concerning the movements of wolves in a restricted area, which may give a more detailed conception of a possible existence of runways.

Description of the study area.—The area in which the present study was made covers Sibley Peninsula, situated in Ontario on the north shore of Lake Superior, east of Port Arthur. It is roughly twenty miles long and six miles wide. The total area of the peninsula is in the neighborhood of 102 square miles. It is situated within the pre-Cambrian shield. The southwesterly tip of the area consists of a rock formation (up to 1850 feet). The height of land is very close to the western shore, resulting in a drainage in an easterly and southerly direction.

The reasons why this peninsula was selected for a study of wolf movements are as follows: Two-thirds of the area includes Sibley Provincial Park, which is a game refuge. Local people claim that this reserve is a breeding place for timber wolves, from which they sally out into the surroundings. If possible, this should be tested. The area is only partly logged over and is in easy commuting distance from Port Arthur. Most of it is fairly easily accessible because of a driveable

road, covering the entire length of the peninsula, and several old logging roads. The peninsular shape of the area makes it easier to estimate how many packs, and possibly wolves, are present. Considerable information about early wildlife conditions in the area, collected by the first and only settlers there, the brothers Cross, was available. Coyotes have a low abundance on the peninsula; timber wolves are easily observable in the winter on Lake Superior and its bays around the area.

Present forest cover.—The forest cover of the peninsula is quite varied. Pulpwood logging commenced around the time of the first World War, but was stopped a few years ago. In one-third of the area, which is only partially logged over, part of the original upper-story, consisting of white pines and white birches, is still standing. White birch (*Betula papyrifera* Marsh) and trembling aspen (*Populus tremuloides* Mich) are the principal deciduous trees in the area, which together with balsam fir (*Abies balsamea* (L) Mill) and white and black spruce (*Picea glauca* (Moench) Voss and *P. mariana* (Mill) BSP.) place the forest technically within the Boreal Forest Region. However, scattered localities where white pine or white cedar at least share dominance, suggest a more southern influence, which is further indicated in the occurrence of red pine and black ash in spots. Balsam poplar (*Populus tacamahacca* Mill), jackpine, and tamarack (*Larix laricina* (Du Roi) Koch) are not uncommon within the area.

Three principal forest types are present in Sibley: deciduous, coniferous, and mixed. The deciduous type is generally an even-aged forest varying from nearly pure birch to nearly pure aspen in content, in most places showing an understory of spruce and balsam. The mixed type generally consists of white birch, a heavy stand of balsam-fir, and some spruce and white cedar (*Thuja occidentalis* L.). The coniferous type occurs largely in the form of upland balsam-spruce stands, but coniferous swamps, in which black spruce, white cedar, and balsam-fir are the principal tree species, are common.

In the shrub story, all depending on forest type and locality, the following shrubs are most commonly encountered: red osier dogwood (*Cornus stolonifera*), hazelnut (*Corylus cornuta*), alders (*Alnus incana* and *Alnus crispa*), and mountain maple. In spots there is considerable regeneration of balsam, aspen, and cedar. The following plants are most commonly found in the herb story: large-leaved aster, sarsaparilla (*Aralia nudicaulis*), thimbleberry (*Rubus parviflorus*), bunchberry (*Cornus canadensis*), and northern lily.

Wildlife populations.—The fauna of the peninsula is still fairly representative for the general area. The marten, and likely the fisher and the lynx, have disappeared, however. While the woodland caribou was the most abundant big game animal at one time, it is practically gone at present. Moose were apparently absent from the area until around the turn of the century, but are now present in fair numbers. White-tailed deer arrived on the peninsula around the turn of the century. At present the deer population is close to the carrying capacity of the range. Black bear, red fox, and weasels are common. The bobcat has apparently replaced the lynx, but seems to be still uncommon. Beaver are abundant, varying hares are on the increase, and muskrats are uncommon. Otter, mink,

and skunk are uncommon at present. Coyotes which were absent around the turn of the century apparently became common in subsequent years, but are now rare or uncommon.

Former abundance of the timber wolf and the coyote.—The subspecies of timber wolf which inhabits this part of Canada, according to Anderson and Young and Goldman, is *Canis lupus lycaon* Schreber. All old-timers agree that wolves were very scarce in this section of Ontario at the start of this century. Mr. J. Cross, who was born and raised at the tip of the peninsula, took accurate notes on the early abundance of different mammals seen and trapped in the area. He reports that there were no wolves at all on Sibley Peninsula during his childhood and that they appeared after the turn of the century, shortly after moose and deer arrived. The population has varied in abundance since. About thirty years ago, Mr. Cross trapped and poisoned from thirty to forty wolves, in one winter, within the area and on the bays around it. The largest wolf pack he ever encountered on Sibley was one of thirteen to fourteen individuals, on the basis of a track count. It is not known whether the wolf population of Sibley has been on the increase or decrease within the last decade, but there seem to be fewer now than there were thirty years ago. The wolf population of Northwestern Ontario in general has shown a slight increase throughout the last ten years.

The coyote was, according to Mr. Cross, absent from the area around the turn of the century. He also stated that it came into Sibley quite a bit later than timber wolves. Apparently, coyotes were fairly common about twenty years ago, for in one winter the Cross brothers collected twenty of them around that time. Mr. Watson, an old fisherman who lives on Squaw Bay, also stated that coyotes were abundant twenty years ago. Practically no records are available concerning the occurrence of the coyote on Sibley Peninsula during the last few years, but undoubtedly a few are present in the area. One animal, described as a coyote, was noticed near the Fishermen's village on April 25, 1949. Tracks and droppings, possibly of coyotes, were found in different parts of the area. They were heard and seen along the north shore of Thunder Bay about ten miles west of the peninsula during the winter of 1948–49.

Present abundance and movements of timber wolves.—The information presented was collected from the following sources: Interviews of residents of the area; interviews of Department of Lands and Forests personnel working in the area; my own field reports, starting December 9, 1947, and those of Mr. A. T. Cringan during the spring and summer of 1948. Detailed records were kept, but will not be presented here.

Sight records: Before the present study got under way, timber wolves were fairly regularly sighted on the ice along the shores of Lake Superior or its bays. Mr. J. Cross saw a wolf pack from the air, several years ago, approximately south of Sibley, halfway between the peninsula and Isle Royale. This indicates that it may not be out of the question that wolves will visit Isle Royale some winter in the future. Mr. Cross also saw wolves travelling from Pie Island to Thunder Cape on Sibley. Wolf packs were sighted on several occasions on the ice on Thunder Bay along the west shore of the Peninsula, and also along the

east shore. They were noticed travelling in different parts of Black Bay and crossing over on different occasions from Edward Island to the Peninsula. Crossings usually take place in a straight line between the nearest points. During the study period, a pack of six wolves was seen by the writer along the east shore of Black Bay Peninsula on February 17, 1948. Packs were seen in the winters of

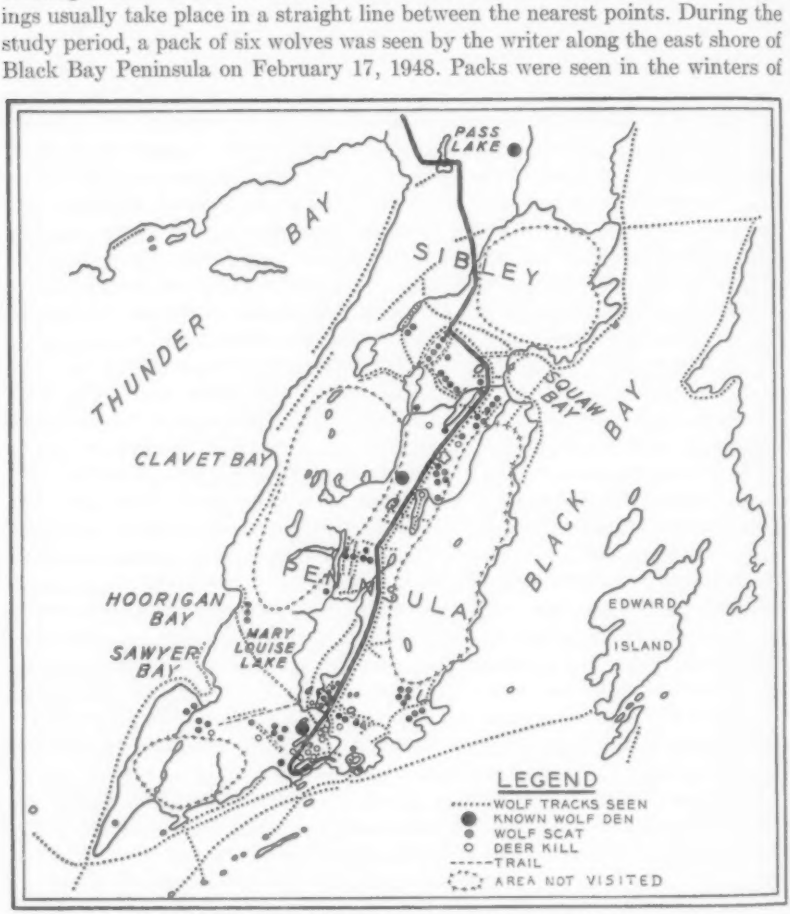

FIG. 1.—Map of Sibley Peninsula, showing data on wolf movements.

1947–48 and 1948–49 on Squaw Bay and during the winter of 1948–49 on Sawyer Bay.

On the Peninsula itself, individual wolves were seen on six different occasions from July, 1947, to date. A pack, consisting twice of three and twice of four wolves, was sighted four times during the late fall of 1948 in the same general area near the southern tip of the Peninsula.

Track records: Before the movement study was undertaken, track records were kept in the diary of the Cross brothers over the period 1934–1945. They

noticed the tracks of different packs all along the south shore on the Peninsula, between the mainland and several small islands situated south of there, and between those islands themselves. They also noticed wolf tracks several times running from Hoorigan Bay to the southern portion of Marie Louise Lake and from there in an easterly direction. Tracks were seen by a local fisherman along the east shore of the Peninsula throughout a number of years. A local trapper saw wolf tracks all along the west shore and also on the rocky plateau's close to the west shore.

During the study itself many tracks were recorded. During the winter of 1947–48 tracks of individual wolves were seen on a few lakes on the Peninsula and along two trails. During the summer of 1948 tracks of a bitch and pups were seen on sandy beaches on the west shore and also on the south shore. During the winter of 1948–49 single tracks were again found on several lakes, on and crossing the main road, and along five different trails. The tracks of what appeared to be a bitch and two pups were seen by a park ranger along the main road on December 3, and by the writer, on a lake, on December 30. During the early part of the winter of 1949–50, the tracks of single wolves were found along two trails. Tracks of two wolves were found within an interval of four days on two trails, which are about one mile apart. The tracks of a pack of three wolves were noticed on two different occasions, in November, along trails approximately eight miles apart. The tracks o a pack of four wolves were seen once.

Howling records: Howling was heard only during the summer of 1949, between May 16 and December 15. Wolves were heard on seven occasions at four different locations. They were heard on top of the mount on the southwesterly tip of the area on June 2 and June 18, which may indicate the presence of a den around there.

Deer kills and scats: During the period of study, seventeen apparent deer kills, some of them fairly old, were found. Their distribution indicates that deer were killed largely where they were concentrated during the winter. The number of deer kills found is actually surprisingly low, considering the high deer population present in the area.

In all 49 scats were found. More than half of them were found on trails, which may indicate an extensive use of those travelways.

Discussion.—All information concerning sight, track, kill, and scat records has been entered on a map of Sibley Peninsula and surroundings (Fig. 1). It should be noticed here that large parts of the peninsula were not visited at all, because of their inaccessibility.

A glance at this map makes it clear that at one time or another, when Lake Superior is frozen over, wolves follow the shores of the peninsula. They also frequent the lakes on the area during the winter and early spring. Ridges and open-grown plateaus along the west shore are used during the winter and possibly during the summer. Logging roads and trails are used extensively as well in the winter as in the summer. The main road on Sibley is sometimes followed and crossed by wolves at many points, but most frequently between Pickerel Lake and Lake Marie Louise. A wolf scat was found at an altitude of about 1600 feet

on the largest mount in the area, indicating that these predators do not hesitate to climb the steep slopes of sizable mounts.

Three large dots on the map indicate localities where dens were found to be occupied during recent years. It is likely that at least one wolf den is, or has been, used somewhere along the southwest shore. Supposing, on this basis and also on data concerning the summer distribution of wolves, that there are three wolf dens used every year in the area, and estimating an average-sized family to be six (which may be high), then there should be at least eighteen wolves on the peninsula. As the total area is approximately 102 square miles, this means a wolf density of at least one wolf per every six square miles (Seton, and Bailey, give an average of one wolf per three square miles for Canada). During the winter the density may be higher, as it appears that the area is visited during that period by packs, not normally present in the summer (statement of Mr. Cross). Even so, the wolf population does not appear to be alarmingly high.

Conclusions.—Based on the information so far presented, the following can be stated regarding wolf movements in the area.

The travel routes of timber wolves in the study area are apparently mainly influenced by three factors: the topography of the area, the distribution of the most important prey animals, and seasonal changes of the climate. Wolves prefer the easiest possible travelling and, therefore, make use of logging roads, trails, lake shores, and passes between hills.

It appears that the tendency of wolves to cross at some particular places more than at others is merely a result of the topography of the terrain. Wolves repeatedly travel the same ridges, land points in lakes, and ravines, mainly because those are most suitable in regard to the topography of the terrain. The travel routes are different in the winter than in the summer, because in the late winter and early spring wolves travel extensively on the ice along the shores of lakes. They may either follow the shore line into bays or cross those in a straight line. Often they run from land point to land point or from one small island to another in the bays around the peninsula.

No evidence could be collected in this area regarding the existence of definite circuital movements covering entire circuits or specific clockwise or counter-clockwise movements. Undoubtedly the movements of packs or individual wolves are more or less circuital because wolves have a certain restricted home range. However, it appears to the writer that the movements of wolves, apart from being governed by the above-mentioned three factors, are more or less at random, and that the fact that wolves cross the same places regularly is primarily caused by the topography of the terrain and secondarily as a result of their knowledge (learning!) of their home range. Naturally wolves learn to use the topography of their home range to their best advantage and will select the easiest going, so far as the topography of the terrain is concerned, for their cross-country travels. While the pups follow the adults on their hunting trips they will get to know the topography and will use the best travelling routes after having run with a pack for awhile.

It is my opinion that writers in the past have over-emphasized the existence

of circuital movements. Evidence collected seems to indicate that wolves, apart from using travelways governed by the topography of the terrain, move more or less at random. The data collected seem to indicate that the reserve does not have a higher wolf population than do the surrounding areas.

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A MALE GUADALUPE FUR SEAL ON SAN NICOLAS ISLAND, CALIFORNIA

BY GEORGE A. BARTHOLOMEW, JR.

Prior to its nearly complete destruction by sealers, the Guadalupe fur seal, *Arctocephalus townsendi*, was a common resident of the coastal waters of Lower California and of California from the Farallones south (Starks, 1922; Lyon, 1937). The population of this species was so reduced by commercial hunters during the 19th century that in 1892 when C. H. Townsend visited Guadalupe Island, the last known haven for these animals, he saw only seven of them and was unable to collect any specimens (Townsend, 1899). The species was described in 1897 by Merriam from skulls picked up by Townsend on the beach at Guadalupe.

There was no verifiable record of occurrence of this species during the present century until 1928 when a fisherman, W. O. Clover, brought two males to the San Diego Zoo and reported that they had been members of a herd of approximately sixty animals seen by him on Guadalupe (Huey, 1930; Townsend, 1931). The two captive animals lived for approximately a year and Townsend (*op. cit.*) published photographs and a detailed description of them.

The exact circumstances surrounding the capture of these animals were reported in 1928 by Wegeforth in *Zoonooz* for May–June, but since the earlier copies of this publication are not commonly available, extracts from Wegeforth's account are presented below.

"... His [Clover's] first report had been of the presence of possibly sixty seals including bulls, cows and some pups.

On his return to the island [Guadalupe] he found that apparently the entire herd with the exception of six adult bulls had left the shore, but some of the cows were swimming in the water off the rocks. He waited two days hoping they would haul out on the beach, but finally due to threatening weather decided to catch what he was able. He succeeded in catching four in his nets. The two largest

fought their way to freedom and made good their escape, the other two he was able to land and these he brought directly to San Diego, arriving on April 25, 1928. . . ."

Mrs. Belle J. Benchley, Director of the San Diego Zoo, reported (personal communication) that the detailed directions given by Clover for the location of the fur seals were carefully recorded and that in July, and again in September, 1930, she was a member of parties taken by G. Allan Hancock to Guadalupe to search for fur seals. Although the area of actual capture was described as being on Guadalupe, Clover's sailing directions were for Alijos Rocks. Moreover, Clover's description of the cave where the animals were taken could not be precisely matched with any of the sea caves on Guadalupe. In addition, a companion of Clover's gave the number of seals in the original group as 35 to 40. From these facts it would appear unwise to place too much credence in the reliability of Clover's estimate of the number of fur seals on Guadalupe in 1928. Neither of the parties of which Mrs. Benchley was a member, nor any one of the many other groups which have visited Guadalupe since 1928, has been able to find a trace of fur seals. Mrs. Benchley (Zoonooz, Nov., 1935) stated, "Repeated visits to the location described and repeated explorations of Guadalupe Island through the good offices of G. Allan Hancock, resulted in our conviction that the fisherman had done away with all the seals except those brought to San Diego before pretending to disclose their whereabouts."

In the twenty-one years since the capture of the above-mentioned specimens, no authenticated record of occurrence for this species has been published, although Townsend (1930) reported that fur seals were seen by fishermen near the Santa Barbara Islands in the summer of 1929, and Bonnot, Clark, and Hatton (1938) reported that three male *Arctocephalus* were seen during the 1938 Division of Fish and Game sea lion census at an unspecified locality in California (identified in a personal communication from Bonnot as Piedras Blancas, San Luis Obispo County).

Three times during the spring and summer of 1949, through the kindness of the U. S. Navy, I made brief visits to San Nicolas, the outermost of the islands off the coast of southern California. On each trip I saw a single adult male fur seal. Knowledge of fur seals in California waters is so scant that the meager details of the three encounters are here presented.

At 12:50 P. M., on May 12, 1949, while making a census of sea lions at a point about one-half mile south of the western tip of the island, on an extensive flat area of sandstone in which were occasional pot holes and tidal channels, I was startled to hear an unfamiliar deep roaring growl behind me. The animal making the noise had apparently been sleeping in a depression in the rock at least 200 feet from the nearest group of sea lions. It was about five and one-half feet long, weighed an estimated 300 pounds, and had a pointed muzzle and a massive thick neck. The long guard hairs stuck out from its completely dry pelage giving the animal a soft furry outline. The under fur was a dark dull brown, but the guard hairs on the head and neck were tipped with yellowish gray which resulted in these parts of the animal having a grizzled, almost silvery, appearance. The vibrissae were pale yellow and the sides of the snout were rusty brown.

The animal's reaction differed markedly from that of the sea lions on the island, which dash precipitantly into the water at the approach of a human, for it made no attempt to escape to the water when it became aware of my presence. Instead, it held its ground and, with teeth bared, growled steadily as I watched it through my binoculars from a distance of not more than twenty-five feet. After perhaps three minutes the animal backed slowly into a small tidal channel and swam leisurely and silently away and out of sight.

On June 19, 1949, with the assistance of William G. Reeder, seven hours were spent searching over the rugged southwest coast of San Nicolas making another census of the sea lions and looking for fur seals. At 4:30 P. M., at a point about one quarter-mile south of the western tip of the island, we found either the individual described above or another one of similar size and appearance. It was sleeping at the base of a ten-foot terrace about 125 feet from the water and approximately six feet above high tide on an extensive level sandstone shelf. Except for a female California sea lion and pup which were sleeping about fifteen feet away, there were no other pinnipeds within 100 feet. The fur seal had assumed a posture frequently used by sleeping sea lions. It lay flat on its belly with neck extended, rear flippers pointed anteriorly and tucked in underneath the belly, and front flippers pressed back flat against its sides.

Reeder and I crawled to the edge of the terrace. As I was focusing my camera, the seal became aware of our presence, stood up, turned its head, and growled at us. Since the animal showed no signs of fright, I stood up in full view and took a picture from a distance of about twenty feet. The seal made no attempt to escape so we dropped down out of sight and descended to the level where he was standing, in an effort to obtain more favorable light for photography. We walked slowly and directly toward him. As I was preparing to photograph him from a distance of about fifteen feet, the animal charged us. After chasing us for about forty feet it stopped, whirled about, and galloped in the opposite direction for approximately 150 feet. It then paused, turned, and watched us quietly. During both our approach and its charge, it kept up a continuous deep growling. After a couple of minutes it entered a tidal pool and slowly swam about thirty feet with only its back visible above the water. It then climbed out on a rock and shook itself vigorously in the fashion of a dog. After the shaking, the hair on its head, neck, and back appeared to be unwetted, but that on its belly lay flat against the skin.

On July 9, Kenneth Stager of the Los Angeles Museum, William G. Reeder, and I spent eight hours searching for fur seals and making a survey of the sea lions in the rookery on San Nicolas. At 2:00 P. M. we found one adult male fur seal, presumably the same one previously seen, asleep in a shallow depression about forty yards southeast of the spot where the fur seal had been found on June 19. It was approximately sixty feet from the water and at least ninety feet from the nearest sea lion. It was lying on its back with rear flippers extended and front flippers crossed on its belly. We crawled to within twelve feet of it and stood behind some large rocks to photograph it. The clicks of our shutters awakened it and it rolled over with a growl and stood facing us. We made no further attempt to remain inconspicuous, but walked into plain sight to obtain photographs

with which to confirm our identification. The seal appeared completely unafraid and for a period of ten minutes we observed and photographed it from distances of less than thirty feet (Pl. I). At no time did it retreat as we advanced towards it. In order to obtain a close-up photograph, Stager twice moved to within nine or ten feet of the animal, and each time it charged and chased him for twenty or twenty-five feet.

Finally, even though we stood between it and the sea, the fur seal walked slowly and deliberately down to the water. Just as it reached the water's edge, a large bull California sea lion reared head and shoulders out of the water and barked at it from a distance of six or eight feet. The fur seal paused, moved about ten feet to the left, stood motionless for an instant, then entered the water with a rush and, with great speed and vigor, swam seaward under the water. It did not surface within our field of vision.

The pattern of vocalization of the Guadalupe fur seal is markedly different from that of the California sea lion. It apparently rarely, if ever, barks. According to Wegeforth (*op. cit.*), "Their bark is a throaty muffled sound with sometimes almost the tone of a steamboat whistle; it is totally different from the shrill penetrating bark of the sea lion." I have heard three separate types of vocalizations from the fur seal (or seals) observed on San Nicolas. When threatening or charging it uttered a deep roaring growl—a sound reminiscent of that made by the larger cats. While standing quietly or moving slowly it kept up a distinctive call which started as a deep hoarse growl, and ascended the scale to end in a querulous rasping tenor note. On two occasions it uttered a deep barking cough.

The identification of the animal of which the photographs were taken is as certain as is possible under field conditions. The nature of its pelage shows that it is a fur seal. The relatively elongate snout, low forehead, and the slope of the anterodorsal aspect of the skull identifies it as a member of the genus *Arctocephalus*, rather than the genus *Callorhinus* (see Figs. 349 and 352 in Townsend, 1931). Since the only species of *Arctocephalus* known to have occurred on the California coast within historic times is *townsendi*, there can be little doubt that the animal (or animals) observed on San Nicolas should be classed as a Guadalupe fur seal. Moreover, the similarity between the photographs of captive Guadalupe fur seals taken at the San Diego Zoo (see Figs. 346–348 in Townsend, *op. cit.*) and those taken of the fur seal on San Nicolas is so close that the identity of the latter can hardly be questioned. The only other possibility is the exceedingly remote one that the animal in question could have been a wandering member of a species of *Arctocephalus* from the Galapagos or the southern hemisphere.

The coast of San Nicolas is extensively dissected and there are along it a number of sea caves that are inaccessible from shore. It is entirely possible that there were in the area fur seals other than the one (or two, or three) reported here. Certainly it seems reasonable to assume that somewhere off the coast of California or Lower California there exists a small breeding colony of these fur seals. The alternative to such an assumption is that the animal seen on San Nicolas is the lone survivor of the herd reported as being on Guadalupe in 1928.

The animal (or animals) described here represents the second authenticated

PLATE I

Two views of an adult male Guadalupe fur seal. The light line along the dorsal surface of the head and neck is caused by the silvery sheen of the guard hairs

record of a living Guadalupe fur seal during the present century, and the first verifiable observation of a living representative of this species from United States waters, but more important, it shows that *Arctocephalus townsendi* is not yet extinct, and it strongly implies that there still exists at some unknown spot a breeding colony of the Guadalupe fur seal.

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A STUDY OF THE REPRODUCTIVE CAPACITY OF MAINE MUSKRATS

By Jay S. Gashwiler

Knowledge of the reproductive capacity of any wildlife species is necessary if its most effective management is to be attained. So far as the writer is aware, no intensive study has ever been made of the rate of reproduction of the common muskrat (*Ondatra zibethica zibethica*) in New England. Seamans (1941) did some work on embryo counts in Vermont, but he examined only a limited number of pregnant females. The nearest known intensive investigations are those in Maryland by Smith (1938) and by Dozier (1947). These studies deal with the Virginia muskrat (*Ondatra zibethica macrodon*), and are based partially on penned animals. Consequently, their findings would probably not apply to the common muskrat ranging naturally in Maine.

A muskrat project was conducted in central and eastern Maine by the writer for the Maine Cooperative Wildlife Research Unit from 1945 until early summer of 1948. Part of the over-all project consisted of an investigation of the muskrats' reproduction. Although the data are admittedly not as extensive as would be desired, they are being presented with the thought that they may be of value and of interest to other wildlife workers.

The investigation fell naturally into a study of muskrat uteri, including placental scars and embryos, and a study of litters. Each will be discussed under its respective heading in the following discourse.

UTERI STUDY

Spring muskrat uteri were obtained entirely from animals trapped for their fur. The trappers were very helpful and co-operated by recording the place and date of capture on a tag and then tying it to each carcass. Fall muskrat trapping became legal in 1947 and only a few carcasses were obtained then. Additional fall and early winter specimens were captured in mink and beaver traps and a very few were taken under permit by the writer.

Practically all of the uteri reported herein were examined when fresh; preserved specimens are much more difficult to examine and the results are not as satisfactory. The uteri were examined for placental scars by stretching each horn and holding it so a strong light would shin through it. The scars were thus thrown into relief and made easily visible for counting; relative size and degree of pigmentation were readily evident. Those uteri containing embryos were examined in the same manner, but in addition, embryo numbers could be determined by pulling each horn between the thumb and index finger so the

TABLE 1.—*Placental scars in thirteen fall-trapped adult muskrats*

PLACE AND YEAR	TOTAL NUMBER	NUMBER WITH SCARS	PER CENT WITH SCARS	TOTAL NUMBER OF SCARS	AVERAGE NUMBER OF SCARS
Barn Meadow (1946)	7	4	57	55	13.7
Pushaw Stream and miscellaneous brooks (1947)	6	5	83	78	15.6
Total	13	9	69	133	14.8

nodular swellings could be felt. The presence of groups of swollen blood vessels in the uteri mesentery was also useful in helping to locate the embryos.

Placental scars.—A relatively large number of uteri from spring-trapped muskrats was examined for placental scars. However, the uncertainty of accurately interpreting these data prohibits their use at this time. It will probably suffice to say that many of the spring-trapped females possessed visible placental scars of the previous season in various stages of retrogression. It is not definitely known by the writer just when these scars are completely absorbed. On the other hand, current season placental scars on uteri obtained during the fall are conspicuous, and if reasonable care is used they appear to be good indicators of the current reproduction.

Only thirteen adult female muskrat carcasses were obtained during the fall and early winter. The results of the examination of their uteri are given in Table 1. From the table it can be seen that only nine of the thirteen adult females examined had placental scars. Although this suggests that only 69 per cent of the females produce young each year, the Maine data are too few on this point and field experience indicates this figure to be much too low. Errington (1940) found that 95 per cent of seventy-six common muskrats examined in Iowa had apparently produced young. The nine females which had produced young

had a total of 133 scars—an average of 14.8 per individual. Seven were considered to have had two litters and two may have had three each. However, this is based entirely on the degree of pigmentation of the placental scars and should be considered only as suggesting the possibility of a third litter.

Embryos.—A total of 494 muskrat uteri, obtained during the spring trapping season, was examined for embryos during the study. The results of this examination are presented in Table 2. The table reveals that forty-five, 9.1 per cent, of the 494 females trapped in April and May contained embryos of sufficient size to be found by gross examination. It should be emphasized that undoubtedly more than 9.1 per cent of the females were pregnant at that time; zoologists at the University of Maine are of the opinion that it would take from ten to fourteen days after the ova are fertilized before embryos would be found in the uteri by gross examination. Therefore, the females handled could have been pregnant without embryos being evident. The weekly increase in the number of females with embryos is of interest—from nearly 3 per cent for the first week

TABLE 2.—*Embryo study of 494 uteri from spring-trapped muskrats*

PERIOD	TOTAL FEMALES	FEMALES WITH EMBRYOS		EMBRYOS	
		Number	Per Cent	Number	Average
April 1–6	136	4	2.9	25	6.2
April 7–13	196	16	8.2	114	7.1
April 14–20	133	18	13.5	135	7.5
April 21–27	22	6	27.3	43	7.2
April 28–May 4	3	1	33.3	5	5.0
May 5–11	4	—	—	—	—
Total	494	45	9.1	322	7.1

in April to 27 per cent the fourth week. Data for the following fifth and sixth weeks are too few to be of much significance. The forty-five sets of embryos ranged in number from two to ten, an average of 7.1 embryos each. Seamans (1941) reported on five pregnant females in Vermont. One had 8 embryos, three had 7 each, and one had 5 embryos, an average of 6.8 embryos per litter. This is slightly less than the number found for Maine, but they are in reasonably close agreement. Errington (1939) reported that six Iowa females had five to eleven embryos with an average of 8.2. Smith (1938) examined ten pregnant females of the Virginia muskrat in Maryland and found that they averaged 4.4 embryos each. Arthur (1931) examined 1058 pregnant Louisiana muskrats (*Ondatra zibethica rivalicia*) which averaged 3.8 embryos per litter. From this it can be seen that the Maine muskrat, while averaging fewer embryos than the Iowa sample, still bore 2.7 more embryos per female than did the Maryland animals and 3.3 more embryos than did those of Louisiana.

LITTER STUDY

The muskrat trapping seasons in Maine have been such that a large per cent of the animals are taken each spring. Those which escape do so chiefly because

they are in habitat so dense or so isolated as to be inaccessible or to make it unprofitable for the trapper to catch them. As a result, the breeding muskrats in areas open to trapping are generally widely scattered and are difficult to find. To locate litters in such places is time-consuming and often fruitless. For that reason much of the litter work was done at the Moosehorn National Wildlife Refuge, Milltown, Maine, where a relatively heavy undisturbed muskrat population exists.

In the early spring the ice, high water, and wind destroy many of the houses near the deeper water where the muskrats winter. This, in conjunction with their apparent preference for dense litter rearing cover, good house bases, and possibly early developing food resources is considered to be responsible for their early spring shift to the edge of the marshes. The majority of the breeding structures are spring-built or are old houses which have been greatly improved. Material which is readily available, such as green and dead herbaceous vegetation, is widely used for building. Some houses have large quantities of wood used in their construction; often this is debris which has accumulated on the marsh although live shrubs are frequently cut and used.

The muskrat litters were found by opening the houses and feeling in the nests and runways for the young. As soon as the young gained a little size they became very active and were difficult to catch. After examination, each house was carefully closed so as to cause a minimum of disturbance. Only house litters were considered in this study—to have opened burrows would have destroyed many of them.

By using the growth-length curve established by Errington (1939), the birth dates of all the litters were determined. While there may be some difference in growth between Iowa and Maine muskrats it would probably be too small to invalidate the data greatly. In 1946 the first litter was calculated to have been born May 7. The first litter in 1947 was also born May 7, while the last one came on August 20. In 1948 the first litter was considered to have been born May 8. Errington (1940) stated that litters were born in Iowa from April to September. Smith (1938), in speaking of the Virginia muskrat in Maryland, says, "Most of the young are born, however, from mid-April to mid-September." From these data it would appear that the muskrats of Iowa and Maryland have at least a month longer reproductive period than do those of Maine.

A total of 62 litters, considered to be complete, was found during the study; these data are tabulated in Table 3. The yearly increase in litter size from 1946 to 1948 is thought to be due to the small size of the samples. The sixty-two litters ranged in size from two to nine, an average of 5.4 young each. Errington (1939) found that 158 complete Iowa litters, mostly less than a week old, ranged in size from one to eleven, and averaged 6.5. Thus, it can be seen that Maine litters were 1.1 animals smaller than those reported for Iowa. It is also of interest to note that the average size of Maine muskrat litters was 1.7 young less than the average embryo litter size. This would represent the mortality suffered from birth to about two weeks of age if resorption is not considered. Errington's figures for Iowa disclose exactly the same amount of decrease in litter size.

There has been much debate on the number of muskrat litters produced per year in New England—estimates have ranged from one to five with no conclusions reached. In 1947 the marshes were checked at short intervals all during the reproductive period, since it was thought the period or periods when the young were most abundant would be evident by the numbers found. The birth dates of the fifty-three litters found were then plotted and a curve drawn. While more litters would have been desired the curve did show some trends which were of interest. Two major peaks occurred in the curve; one came about the first week of June and the other about the second week of July. These were interpreted as representing the periods of occurrence of first and second litters. Since muskrats are considered to breed shortly after giving birth to young, and have a gestation period of 29–30 days, this represents about the proper time interval between litters. There was a slight rise in the curve near the end of the reproductive period. This was interpreted as representing either second littters of individuals not closely synchronized with the main group, or a few animals having third litters.

TABLE 3.—*Complete muskrat litter size by years*

YEAR	NUMBER OF LITTERS	NUMBER OF INDIVIDUALS	AVERAGE LITTER
1946	17	82	4.8
1947	31	163	5.3
1948	14	90	6.4
Total	62	335	5.4

As was previously mentioned, the study of the placental scars suggested the possibility of some of the muskrats having three litters per season. The curve of the birth dates of the 1947 litters also reveals the possibility of a third litter. However, if the average number of placental scars (14.8) per year is divided by the average embryo litter (7.1) we get a little over two which would represent the number of litters per year. Thus, it can be seen that although data on this point are not entirely conclusive, most of the mustrats in Maine have two litters per year—with a few perhaps having a third. Errington (1940), writing of the number of litters in Iowa, states, "Successive litters were born to individual females at intervals averaging about a month, and numbers of litters per female varied from one to four, with two litters of usual, and three of frequent, occurrence (Errington, 1937b, and unpublished)." Smith (1938) writing of the Virginia muskrat in Maryland states, "Two litters in one year were the most obtained from pen-raised animals."

SUMMARY

A study was made of muskrat uteri and litters from 1945 to 1948 in central and eastern Maine.

A small sample of fall-trapped adult females examined for placental scars revealed an average of 14.8 scars per female.

Forty-five pregnant females taken in the early spring had an average of 7.1 embryos each.

The average size of 62 litters, considered to be complete, was 5.4 young each.

The number of litters per female per year was found to be two, with possibly a few instances of three.

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LOCALITY RECORDS OF AFRICAN MAMMALS

By Ken Stott, Jr.

It is hoped that the following locality records of African mammals will contribute to a more comprehensive understanding of the distribution of the forms concerned as well as fulfill their primary obligation, that of supplying additional published occurrence records for reference purposes. The observations were made during the summer and early fall of 1948 at which time I visited Africa under the auspices of the Zoological Society of San Diego. This compilation was made at the suggestion of Dr. E. Schwarz of Washington, D. C., whom I met while in Africa. Dr. Schwarz, a member of the U. S. Navy Medical Science group, generously consented after our return to read this manuscript and holds himself responsible for the identifications and the nomenclature.

The problem of designating the geographical point or points at which each species was encountered is a difficult one. Since exact distances could not ordinarily be taken, it would seem best for the purposes of this list to select the nearest village in each case as the reference point. When considering the records of mammals along the Nile, the reader should keep in mind the fact that a phrase such as, "Terakeka, on east bank of White Nile," signifies that the animal in

question, not Terakeka, was observed on the east bank. Terakeka remains on the west bank.

ACCOUNTS OF SPECIES

CERCOPITHECIDAE

Cercopithecus aethiops aethiops (Linnaeus). Grivet.—Sudan: Jebelein, on east bank of White Nile; Geigar, on west bank of White Nile; Terakeka, on west bank of White Nile.

Cercopithecus aethiops centralis Neumann. Uganda: Rhino Camp, on west bank of Albert Nile.

Cercopithecus aethiops cynosuros (Scopoli). Belgian Congo: Leopoldville II.

Cercopithecus aethiops johnstoni Pocock. East African vervet.—Kenya: Athi River, Nairobi National Park; Rumuruti. Tanganyika: Ngare Nanyuki.

Cercopithecus aethiops pygerythrus (F. Cuvier). Vervet.—Transvaal: White River; Kruger National Park (Pretoriuskop; Skukuza; Tshokwane; Pafuri).

Cercopithecus mitis kibonotensis Lönnberg. Tanganyika: Mto wa mbu (between Oldeani and Arusha).

Cercopithecus mitis kolbi Neumann. Kolb's monkey.—Kenya: Nyeri; Thomson's Falls.

Papio ursinus ursinus (Kerr). Chacma baboon.—Transvaal: Kruger National Park (Tshokwane; Satara; Pafuri); Hartebeestport Dam.

Papio anubis anubis (Fischer). Uganda: south of Nimule, Sudan, on east bank of Albert Nile; Rhino Camp, on east bank of Albert Nile.

Papio anubis neumanni Matschie. Anubis baboon.—Kenya: Rumuruti; Njorowa Gorge (Naivasha).

MUSTELIDAE

Mellivora capensis sagulata Hollister. Ratel.—Tanganyika: Ngare Nanyuki.

CANIDAE

Lycaon pictus pictus (Temminck). Hunting dog.—Transvaal: Kruger National Park (Skukuza).

Octocyon megalotis virgatus Miller. Bat-eared fox.—Kenya: Nairobi National Park; Wamba.

Lupulella mesomelas mesomelas (Schreber). Black-backed jackal.—Transvaal: Kruger National Park (Pretoriuskop; Skukuza).

Lupulella mesomelas mcmillani (Heller) (subspecific status doubtful). Kenya: Nakuru; Magadi; Wamba. Tanganyika: Ngare Nanyuki; Arusha.

VIVERRIDAE

Ichneumia albicauda ibeana (Thomas). White-tailed mongoose.—Kenya: Nairobi, Nyeri.

HYAENIDAE

Crocuta crocuta crocuta (Erxleben). Spotted hyena.—Transvaal: Kruger National Park (Skukuza).

Crocuta crocuta germinans (Matschie). Kenya: Nairobi National Park; Nyeri; Wamba.

FELIDAE

Acinonyx jubatus velox Heller. Cheetah.—Kenya: Nairobi National Park.

Felis caracal subsp. Caracal.—Kenya: Njorowa Gorge (Naivasha).

Panthera leo melanochaitus (Hamilton Smith). Cape lion.—Transvaal: Kruger National Park (Skukuza; Punda Maria; Dzundweni).

Panthera leo massaica (Neumann). Masai lion.—Kenya: Nairobi National Park.

Panthera pardus suahelica (Neumann). Leopard.—Kenya: Magadi Road at foot of southwestern slope of Ngong Hills.

PEDETIDAE

Pedetes cafer surdaster Thomas. Springhaas.—Kenya: Naivasha.

ELEPHANTIDAE

Loxodonta africana africana (Blumenbach). Bush elephant.—Kenya: Nyeri; Kisima Transvaal: Kruger National Park (Schingwedzi).

Loxodonta africana oxyotis (Matschie). Sudan elephant.—Sudan: Lake No; Ryer, on west bank of Bahr el Jebel; Adok, on east bank of Bahr el Jebel.

Loxodonta africana subsp. Uganda: Rhino Camp, on east bank of Albert Nile; Pakwach, on east bank of Albert Nile.

HIPPOPOTAMIDAE

Hippopotamus amphibius amphibius Linnaeus. Northern hippopotamus.—Sudan: first observed in the White Nile a few miles south of Kosti; became increasingly numerous as we moved up river; other Sudanese points at which hippos were observed: Geigar; Jebel Ahmed Aga; Shambe; Nimule. Uganda: Rhino Camp.

Hippopotamus amphibius capensis Desmoulins. Cape hippopotamus.—Transvaal: Kruger National Park (Sabi River near Skukuza; Olifants River; Letaba River).

Hippopotamus amphibius kiboko Heller. East African hippopotamus.—Kenya: Athi River, in Nairobi National Park.

SUIDAE

Hylochoerus meinertzhageni meinertzhageni Thomas. Giant forest hog.—Kenya; Nyeri.

Phacochoerus africanus massaicus Lönnberg. Kenya: Nyeri; Rumuruti.

Phacochoerus africanus sundevallii Lönnberg. Wart hog.—Transvaal: Kruger National Park (Leeupan, Tshokwane).

GIRAFFIDAE

Giraffa capensis capensis (Lesson). Cape giraffe.—Transvaal: Kruger National Park (Pretoriuskop; Skukuza).

Giraffa capensis tippelskirchi Matschie. Masai giraffe.—Kenya: Nairobi National Park; slopes of Ngong Hills; Naivasha. Tanganyika: plain at foot of northwestern slope of Kilimanjaro; Arusha; Mto wa mbu.

Giraffa camelopardalis reticulata de Winton. Reticulated giraffe.—Kenya: 15 miles north of Nanyuki; Isiolo; Archer's Post; Wamba; Maralal.

BOVIDAE

Alcelaphus buselaphus cokii Günther. Coke's hartebeest.—Kenya: Nairobi National Park; 20 miles north of Magadi; Naivasha. Tanganyika: Mto wa mbu; Ngorongoro.

Alcelaphus buselaphus jacksoni (Thomas). Jackson's hartebeest.—Uganda: Rhino Camp, on east bank of Albert Nile.

Alcelaphus buselaphus jacksoni x coki. Kenya hartebeest.—Kenya: north of Rumuruti.

Connochaetes taurinus taurinus (Burchell). Brindled wildebeest.—Transvaal: Kruger National Park (Pretoriuskop; Tshokwane).

Connochaetes taurinus albojubatus Thomas. White-bearded wildebeest.—Kenya: Nairobi National Park. Tanganyika: plain at foot of northwestern slope of Kilimanjaro.

Connochaetes taurinus hecki Neumann. Tanganyika: Mto wa mbu; Ngorongoro.

Damaliscus korrigum tiang (Heuglin). Tiang.—Sudan: Wath Wang, on east bank of White Nile; Kenisa, on west bank of Bahr el Jebel.

Damaliscus lunatus (Burchell). Sassaby.—Transvaal: Kruger National Park (Shingwedzi).

Damaliscus pygargus albifrons (Burchell). Blesbok.—Transvaal: Rietvlei Dam Sanctuary (near Pretoria).

Cephalophus natalensis natalensis A. Smith. Red duiker.—Transvaal: Kruger National Park (Pretoriuskop).

Sylvicapra grimmia grimmia (Linnaeus). Grey duiker.—Transvaal: Kruger National Park (Pretoriuskop; Punda Maria).

Sylvicapra grimmia hindei (Wroughton). East African crowned duiker.—Kenya: Naivasha. Tanganyika: Ngare Nairobi.

Oreotragus oreotragus schillingsi Neumann. Klipspringer.—Kenya: Gilgil; Njorowa Gorge (Naivasha).

Nesotragus moschatus akeleyi Heller. Suni.—Kenya: Nairobi.

Raphicerus campestris capricornis Thomas and Schwann. South African steinbok.—Transvaal: Kruger National Park (Pretoriuskop; Skukuza; Shingwedzi; Punda Maria).

Raphicerus campestris neumanni (Matschie). Neumann's steinbok.—Kenya: Magadi. Tanganyika: Arusha.

Rhynchotragus kirkii subsp. Long-snouted dik-dik.—Kenya: Wamba; Magadi.

Adenota kob leucotis (Lichtenstein and Peters). White-eared kob.—Sudan: Jebel Ahmed Aga, on east bank of White Nile; west of Tonga, on west bank of White Nile.

Adenota kob thomasi (P. L. Selater). Uganda kob.—Uganda: Rhino Camp, on east bank of Albert Nile.

Adenota leche megaceros Fitzinger. Nile lechwe.—Sudan: East of Tonga, on west bank of White Nile (herd of approximately 200); west of Tonga, on both banks; south of Lake No, on east bank of Bahr el Jebel; Ryer, on east bank of Bahr el Jebel.

Kobus ellipsiprymnus ellipsiprymnus (Ogilby). Common waterbuck.—Transvaal: Kruger National Park (Skukuza; Letaba; Shingwedzi; Punda Maria).

Kobus defassa harnieri (Murie). Defassa waterbuck.—Sudan: Jebel Ahmed Aga, on east bank of White Nile; south of Lake No, on east bank of Bahr el Jebel; Adok, on both banks of Bahr el Jebel; Terakeka, on east bank of Bahr el Jebel.

Kobus defassa ugandae Neumann. Uganda: south of Rhino Camp, on east bank of Albert Nile.

Redunca redunca cottoni (W. Rothschild). Bohor reedbuck.—Sudan: Detwok (between Melut and Kodok), on west bank of White Nile.

Redunca arundinum arundinum (Boddaert). Reedbuck.—Transvaal: Kruger National Park (Satara).

Redunca fulvorufula chanleri (W. Rothschild). Chanler's mountain reedbuck.—Kenya: Njorowa Gorge (Naivasha).

Aepyceros melampus melampus (Lichtenstein). Impalla.—Transvaal: Kruger National Park (Pretoriuskop, Skukuza, Shingwedzi, Punda Maria).

Aepyceros melampus suara (Matschie). Kenya: Gilgil; Naivasha; Maralal; Nairobi National Park. Tanganyika: Ngare Nairobi; Ngare Nanyuki; plain at foot of northwestern slope of Kilimanjaro.

Antidorcas marsupialis marsupialis (Zimmermann). Springbok.—Transvaal: Rietvlei Dam Sanctuary (near Pretoria).

Gazella gazella thomsonii Günther. Thomson's gazelle.—Kenya: Nakuru; Naivasha; Maralal; Kisima; Nairobi National Park. Tanganyika: Mto wa mbu; Arusha; Ngare Nanyuki.

Gazella dorcas dorcas (Linnaeus). Dorcas gazelle.—Egypt: Abu Simbel, on west bank of Nile.

Gazella granti subsp. Grant's gazelle.—Kenya: Nakuru; Nairobi National Park; Wamba; Maralal; Magadi. Tanganyika: Mto wa mbu; Arusha; Ngare Nanyuki.

Litocranius walleri walleri (Brooke). Gerenuk.—Kenya: Magadi; Isiolo; Archer's Post; Wamba.

Hippotragus equinus equinus (Desmarest). Roan antelope.—Transvaal: Kruger National Park (Shingwedzi; Punda Maria).

Hippotragus niger niger (Harris). Sable antelope.—Transvaal: Kruger National Park (Pretoriuskop).

Oryx beisa beisa (Rüppell). Beisa oryx.—Kenya: Wamba.

Strepsiceros strepsiceros strepsiceros (Pallas). Greater kudu.—Transvaal: Kruger National Park (Pretoriuskop; Skukuza; Shingwedzi; Punda Maria; Pafuri).

Strepsiceros imberbis australis (Heller). Lesser kudu.—Tanganyika: Ngare Nairobi.

Tragelaphus angasii Gray. Nyala.—Transvaal: Kruger National Park (Punda Maria; Pafuri).

Tragelaphus scriptus delamerei Pocock. Lord Delamere's bushbuck.—Kenya: Nyeri.

Tragelaphus scriptus roulaleyni Thomas. Limpopo bushbuck.—Transvaal: Kruger National Park (Pretoriuskop).

Tragelaphus spekii spekii P. L. Sclater. Sitatunga.—Sudan: 5 kilometers east of Lake No, on west bank of White Nile.

Taurotragus oryx pattersonianus Lydekker. Patterson's eland.—Kenya: Nairobi National Park; southeastern slope of Ngong Hills.

Syncerus caffer caffer (Sparrman). Cape buffalo.—Transvaal: Kruger National Park (Dzundweni).

Syncerus caffer radcliffei (Thomas). East African buffalo.—Uganda: south of Rhino Camp, on east bank of Albert Nile; east bank of Albert Nile at outlet of Lake Albert. Kenya: Ngong Hills. Tanganyika: Mto wa mbu.

RHINOCEROTIDAE

Diceros bicornis (Linnaeus). Black rhinoceros.—Uganda: south of Rhino Camp, on east bank of Albert Nile. Kenya: Nyeri; Wamba. Tanganyika: plain at foot of northwestern slope of Kilimanjaro.

EQUIDAE

Dolichohippus grevyi (Oustalet). Grevy's zebra.—Kenya: Wamba.

Hippotigris quagga böhmi (Matschie). East African zebra.—Kenya: Nakuru; Naivasha; Wamba; Maralal; Nairobi National Park. Tanganyika: Ngorongoro; Mto wa mbu; Arusha; plain at foot of northwestern slope of Kilimanjaro.

Hippotigris quagga chapmani (Layard). Chapman's zebra.—Transvaal: Kruger National Park (Pretoriuskop; Shingwedzi; Punda Maria).

Zoological Society of San Diego, San Diego, California. Received May 10, 1949.

GENERAL NOTES

THE STATUS OF *LASIURUS BOREALIS SEMINOLUS* (RHOADS)

In this Journal for November, 1948 (29: 415–416), F. S. Barkalow, Jr., presents evidence, based on observations at Auburn, Lee County, Alabama, that *Lasiurus borealis seminolus* (Rhoads) merits full specific rank. I am in complete agreement with his conclusions, and in support of his contention wish to record the following data from South Carolina.

Both *Lasiurus borealis* and *seminolus* are resident near Charleston throughout the year, as Table 1, of specimens in my collection, will show. I have enumerated only those specimens which were collected in an area of a few square miles on the west bank of the Ashley River, within five miles of Charleston.

I am well aware, of course, that related subspecies may inhabit the same general area without coming into actual contact with each other. Dice has pointed out (Jour. Mamm., 12: 210–213, 1931) that this is true of several subspecies of the genus *Peromyscus*. In the case

TABLE 1.—*Number of specimens of Lasiurus borealis and L. seminolus collected near Charleston, South Carolina, throughout the year*

MONTH	NUMBER OF SPECIMENS	
	borealis	*seminolus*
January	2	4
February	2	4
March	5	3
April	1*	2
May	2	2
June	2	1
July	3	6
August	2	1
September	2*	1
October	1*	5
November	1	4
December	2	5

* Collection of the Charleston Museum.

of *borealis* and *seminolus*, however, it is not a question of the two forms occupying different niches in the same general area; but of their simultaneous, joint occupancy of exactly the same area. A detailed list of the specimens I collected in 1940 and 1941 will make the point clear (Table 2). I have listed only those specimens which were collected within a very circumscribed area. Three of the localities referred to—Old Fort Bull, Olde Towne Road, and Ashley Hall Road—form a small triangle whose sides are approximately four miles, one mile, and three and a half miles long. Orange Grove Road is included within this triangle. Drayton Hall is about two miles outside the triangle.

It will be noted that both *borealis* and *seminolus* were taken at one point on Ashley Hall Road on 6 July, 1940; and that *seminolus* was taken at the same spot on 16 July, 1940, followed by *borealis* on 17 July, 1940. On 6 December, 1947, one male *borealis* (No. 2098) and two male *seminolus* (Nos. 2096 and 2097) were collected at the same point on Old Towne Road.

Not only do the two forms occur together near Charleston, but they also inhabit exactly the same area farther inland. On 2 July, 1948, I collected a female *seminolus* (No. 2204) and a female *borealis* (No. 2205), both lactating, without moving from my tracks on a narrow, abandoned roadway through mixed woods at a point nine miles north of Orangeburg, South Carolina, and approximately eighty miles inland from Charleston. On the following even-

ing, 3 July, 1948, at exactly the same spot, I collected a second lactating female *borealis* (No. 2213). From these records it seems that there can be no doubt that *borealis* and *seminolus* are both permanently resident in coastal South Carolina.

That both forms breed near Charleston is proved by the following facts: On 22 May, 1946, a female *seminolus* (No. 1871) with two embryos (crown-rump, 23mm.) was taken on

TABLE 2.—*Collection data on two species of Lasiurus*

SPECIMEN NUMBER	DATE COLLECTED	LOCALITY	SPECIES	SEX
1257	February 28, 1940	Old Fort Bull	*seminolus*	♀
1291	June 18, 1940	Old Fort Bull	*seminolus*	♀
1300	June 29, 1940	Old Fort Bull	*borealis*	♀*
1302	July 1, 1940	Ashley Hall Road	*seminolus*	♀
1304	July 5, 1940	Ashley Hall Road	*seminolus*	♀*
1305	July 6, 1940	Ashley Hall Road	*borealis*	♀*
1306	July 6, 1940	Ashley Hall Road	*seminolus*	♀*
1314	July 16, 1940	Ashley Hall Road	*seminolus*	♀*
1317	July 17, 1940	Ashley Hall Road	*borealis*	♂
1333	October 8, 1940	Old Fort Bull	*seminolus*	♂
1334	October 8, 1940	Old Fort Bull	*seminolus*	♂
1335	October 8, 1940	Old Fort Bull	*seminolus*	♂
1339	October 14, 1940	Old Fort Bull	*seminolus*	♂
1354	October 28, 1940	Orange Grove Road	*seminolus*	♂
1432	December 7, 1940	Old Fort Bull	*seminolus*	♂
1481	January 30, 1941	Old Fort Bull	*borealis*	♂
1499	February 14, 1941	Old Fort Bull	*seminolus*	♂
1537	March 3, 1941	Drayton Hall	*seminolus*	♂
1541	March 4, 1941	Old Fort Bull	*seminolus*	♂
1542	March 4, 1941	Old Fort Bull	*seminolus*	♀
1559	March 20, 1941	Drayton Hall	*borealis*	♂
1560	March 20, 1941	Drayton Hall	*borealis*	♂
1564	March 24, 1941	Old Fort Bull	*borealis*	♂
1565	March 24, 1941	Old Fort Bull	*borealis*	♂
1572	March 31, 1941	Old Fort Bull	*borealis*	♂
1576	April 1, 1941	Old Fort Bull	*seminolus*	♀
1599	July 17, 1941	Old Towne Road	*seminolus*	♂
1654	November 15, 1941	Drayton Hall	*seminolus*	♂
1657	November 16, 1941	Ashley Hall Road	*seminolus*	♂
1659	November 17, 1941	Drayton Hall	*seminolus*	♂
1660	November 17, 1941	Drayton Hall	*seminolus*	♂
1661	November 18, 1941	Orange Grove Road	*borealis*	♂

* Collection of the Charleston Museum.

Old Towne Road. On 3 June, 1946, a female *borealis* (No. 1874) with three embryos (crown-rump, 19mm.) was taken on Old Towne Road. In addition, lactating females, as indicated above (Nos. 2204, 2205, 2213) and in Table 2, have been collected.

It thus appears that *borealis* and *seminolus* are concurrently resident throughout the year near Charleston, South Carolina, where they are found inhabiting, at the same time, exactly the same wooded areas, and that both forms breed here in the closest proximity.

I have been quite unable to discover any evidence that the two forms interbreed, or that they are merely color phases of the same animal. The complete absence of intermediate forms and the lack of any color differences in the sexes of *seminolus*, such as occur in *borealis*,

appear to dispose completely of these possibilities. Unless it can be proved, or inferred on some substantial basis, that interbreeding takes place on some circuitous and round-about basis, as happens in some of the races of *Peromyscus*, for example, it appears to me that *seminolus* must be recognized as a full species.—ROBERT H. COLEMAN, *Route 8, Box 615, Charleston, S. C.* *Received August 9, 1949.*

MONTANA RECORDS OF ANTELOPE EMBRYOS AND REPRODUCTIVE TRACTS

During the winter of 1946–1947, the reproductive tracts of six pregnant antelope (*Antilocapra*) were made available through the courtesy of the Montana Fish and Game Commission. Observations were made at Montana State College.

The reproductive anatomy is similar to that of other Ruminata. The ovaries are attached to the ventral surface of the uterus about halfway between the cervix and the tips of the cornua, and average 15 mm. in diameter. The horns of the uterus are relatively shorter than in the goat and sheep, and are connected along the midline for about half their length. The placenta is of the non-deciduate, cotyledonous type similar to that of the cow, although

TABLE 1.—*Data recorded from twin embryos from six antelope taken in Montana*

DATE	AGE, DAYS	SEX	WEIGHT, GRAMS	MEASUREMENTS, INCHES			
				Total Length	Shoulder Height	Leg Length	Ear Length
December, 1946	50	F	36.5	10.0	5.5	2.5	0.4
		F	36.7	11.5	5.5	2.5	0.4
	70	F	55.0	12.0	7.0	3.0	0.7
		F	57.5	11.5	7.0	3.0	0.7
December 31, 1946	80	M	60.5	11.5	6.5	3.0	0.7
		M	55.0	12.0	7.0	3.0	0.7
February 2, 1947	110	F	158.0	15.0	10.0	4.0	1.3
		F	153.0	15.0	9.5	4.5	1.3
January 30, 1947	120	M	160.0	15.7	8.5	4.2	1.1
		M	183.0	15.7	8.5	4.2	1.1
January 30, 1947	150	F	268.5	20.0	11.5	6.0	1.7
		F	260.0	20.0	12.5	6.0	1.7

the cotyledons are smaller, more oblong, and fewer in number (60) than in the cow. They are arranged in two rows as in the sheep. Similar also to the sheep, the portions of the fetal membranes occupying the fundus of the uterus are fused although the sacs remain separate for the amniotic fluid cannot flow back and forth between them. In some cases the anterior end of the embryo is toward the fundus of the uterus, in other cases toward the horns.

Previous records indicate that mature does usually have twins although available data seem to be derived from field observation of young rather than observation of embryos. The data taken on the embryos found in the six females are given in Table 1. The age of the embryos is a rough approximation, derived from the date of capture and the average date of mating for the herd in question. Twins were present in all cases and the members of each pair were always of the same sex. Even for such small numbers this seems an unusual deviation from the expected 50:50 ratio. There is also a rather marked similarity in the measurements of the members of each set of twins. In the sixth set, a small papillose structure on the side of the jaw was repeated precisely in each twin. This would indicate that in this set the twins are identical. It is interesting that the variation in the measurements of the other sets of twins fall well within the range of variation in the measurements of this set. These observations in no way prove that antelope have identical twins with more than average frequency, but they do indicate an interesting problem.

In areas where antelope are plentiful, trapping and transplanting programs are frequently carried out, over considerable portions of the year, and material is often available that would give a better picture of their reproductive cycle than is possible with most other big game animals.—Clarence A. Tryon Jr., and Paul David Buck, *Dept. of Biological Sciences, University of Pittsburgh.* *Received July 26, 1949.*

MOUNTAIN SHEEP DRIVE MULE DEER FROM FOOD

During the severe winter of 1948–49, characterized by unusually heavy snow in the mountainous areas of north-central Colorado, the Game and Fish Department resumed feeding of big game in critical areas where heavy concentrations of deer and elk had precipitated serious damage problems. Feeding in these localities was admittedly more for the purpose of holding animals off of agricultural land than in the hope of getting additional food to large portions of the populations.

On February 11, 1949, the writers observed an example of mountain sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*) behavior that seems worthy of recording. We were driving west on U. S. 6 and 24 and, about 2:00 P.M., just after crossing Vail Pass, we noticed a band of sheep bedded down near a feeding area north of the highway, where they had previously been observed. About two tons of hay, and some salt, had been dropped by plane at this site a day or two before. This particular feeding ground was a steep south slope, relatively free of snow, surrounded by brush and aspen thickets, and protected against northern winds.

We stopped on the roadside to watch the sheep, which were scarcely 100 yards away. The band included young rams, ewes, and lambs; several old rams, we discovered later, were lying quietly in the brush some distance away. While we were still engrossed with the sheep, fourteen mule deer walked out of the surrounding brush and proceeded directly to the scattered hay and began to feed. They would feed briefly on the hay, switch to browse, and then back to hay. Such alternation was so striking that we remarked about it. Sex of the deer was not determined since all bucks had dropped their antlers. They showed no fear of the automobile.

After a few minutes, during which all of the deer consumed some hay, the band of sheep, ten in number, not including the old rams, got up and walked in a body directly to the feeding ground. The reaction of the deer to the advancing sheep was prompt and positive. They retreated before the sheep reached the hay, moving into the surrounding brush cover. The sheep began to feed on the hay when they reached it, unperturbed by our parked automobile.

This is the first instance of apparent dominance of mountain sheep over mule deer that has come to our attention. It should be remembered that the observation was made after the buck deer had dropped their antlers. The reaction of the deer might be different than stated here at other seasons of the year.—Gilbert N. Hunter and Robert G. Kinghorn, *Colorado Game and Fish Department, Denver, Colorado.* *Received July 22, 1949.*

AQUATIC ACTIVITY OF A SNOWSHOE HARE

On July 24, 1949, the writer and his young son were fishing on the Paint River in Iron County, Michigan, about ten miles north of the town of Iron River. At this particular point there is an old logging dam and the water is quite swift and deep below the dam; the river is some forty yards wide.

The day had been a very hot one with very little luck at catching fish, but I was still doggedly casting. On the far bank was a large log which presented a drop of some two or three feet to the water. Out of the brush to the rear of the log came a snowshoe hare (*Lepus americanus*). The hare proceeded onto the log and jumped without hesitation into the river. I first thought this brown object was a mink since it had taken to the water with such alacrity, but as the animal proceeded toward me I could see the large round head, long ears laid back against the head, and large eyes of the hare. The creature appeared to swim with ease, was not swept downstream by the swift water, and made the far bank in a short time. It quickly scrambled out and disappeared into the forest.

The hare seemed to be aware of the presence of both my son and me, but took no alarm. The whole incident gave me the impression that this hare took, as a matter of course, the crossing of forty yards of swift water, and did a very good job of it.—GEORGE S. HUNT, *School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan. Received July 30, 1949.*

TULAREMIA IN THE JUMPING MOUSE

Tularemia, an infection due to *Pasteurella tularensis*, is quite common in rabbits and rodents in such an area as the Jackson Hole Wildlife Park. Tularemic infections may be found in practically all rodents, although to date most of the human cases have been contracted through handling of jack rabbits and cottontails. Kohls (1943, Public Health Reports) reports that tularemia has been demonstrated in the field vole, *Microtus pennsylvanicus modestus*. While conducting a survey to determine the prevalence of tularemia in the Jackson Hole area, I collected eighteen jumping mice, *Zapus princeps*. Bacteriological examinations were made on the mice, and an autopsy was performed to observe the internal organs. None had any lesions of the liver, spleen, or kidney. Examination of each mouse was performed by drawing blood from the heart and inoculating it onto a glucose-blood-cystein agar (Difco) slant. These slants were incubated at 37°C. and examined periodically. After four days of incubation, one slant showed a growth which was characteristic of the tularemia organism on this media. Since this is only a presumptive positive reaction, to verify it a physiologic saline suspension was made of the growth in the slant. This suspension was injected intraperitoneally into a mouse which was kept for laboratory use. This injected mouse was kept in a cage and examined periodically. After the sixth day, the mouse became very sluggish and did not respond to agitation. The laboratory test mouse died on the ninth day. An autopsy showed necrotic foci of the liver, which is a characteristic condition of tularemia infections in mice. A piece of tissue from this infected liver was inoculated onto a glucose-blood-cystein agar slant and incubated at 37°C. for four days. A tularemia-like growth again occurred and, upon making a Gram stain of the organisms, typical *Pasteurella tularensis* cells were observed, which were Gram-negative, capsulated, and pleomorphic.

So far as I have been able to learn, this is the first time tularemia has been reported in the jumping mouse, *Zapus princeps*. I am greatly indebted to Mr. James S. Findley, mammalogist, for the identification of the mice examined.—MITSURU NAKAMURA, *Department of Bacteriology, University of Southern California, Los Angeles, California. Received August 5, 1949.*

MONGOOSE LURING GUINEA FOWL

Major H. K. McKee, Commissioner for Northern Rhodesia, related the following to me: "Some years ago, in Northern Rhodesia, I came upon a Mongoose acting in a very strange manner. He was standing up on his hind legs, and falling over sideways, first to one side, then the other. A flock of guinea fowl were evidentally as surprised and inquisitive as I was, for they drew gradually closer and closer to the performer. Then suddenly the Mongoose sprang on them and in a few leaps killed four of them."—F. W. PRESTON, *Box 149, Butler, Pennsylvania. Received September 13, 1949.*

BREEDING PRODUCTIVITY IN MICHIGAN RED FOXES

Various methods have been devised for determining breeding productivity in wildlife species. In mammals, counts of embryos and placental scars frequently have been used. These give satisfactory results in most cases, but involve collecting of considerable material from the field to provide adequate data.

In many states extremely high fox populations in recent years have encouraged the digging out of dens. In Michigan, such effort has been utilized to provide certain statistical information on annual reproductive rates similar to that furnished by the methods listed above.

Some wildlife workers, notably Sheldon (Jour. Mamm., 30: 236–46, 1949) in New York, believe that litter size in foxes is a less accurate criterion of breeding productivity than are embryo or placental scar counts. Nevertheless, we feel that a consideration of litter size has its value in such studies. Over a four-year period from 1946–49, 210 Michigan red fox litters removed from dens by field co-operators have shown an average recovered litter size of 4.92. This figure includes litters taken from all parts of the state. Litters averaged considerably larger in the southern counties than in the north. In the Upper Peninsula the average size was 4.2 (25 litters); in the northern half of the Lower Peninsula, 4.27 (48 litters); and in the southern half of the Lower Peninsula, 5.35 (137 litters). The latter figure approximates Sheldon's average of 5.37, based on a count of embryos and placental scars.

Litters recovered from dens undoubtedly provide a conservative figure. All of the pups are not necessarily collected in every case; they may escape or be removed by the parents immediately prior to or during the excavating process. Actual reproductive success, therefore, is undoubtedly greater than the indicated 4.92, and may actually be nearer 5 or 6.

When records on Michigan fox litters were being collected, two unusually large "litters" were noted. These were of 14 and 15 pups each (not included in the above computations), and probably represented litters of two or more females. They may also, as Sheldon suggests, indicate polygamous tendencies in the red fox. Seton and other workers have listed 9–10 as the maximum number of embryos occurring, and it seems reasonable to believe that litters normally do not exceed this figure. Recently, however, an interesting Michigan record came to the writer's attention. Roy Welsh shot a fox on February 14, 1949, near Charlotte, Michigan, which seemed to have an unusually distended abdomen. His curiosity prompted him to cut the animal open whereupon he found eleven well-formed embryos, each about 1½ inches long. Unfortunately these embryos were not saved so they could be examined by a biologist, but the incident was recorded very soon afterward in the form of an affidavit, and we have no reason to doubt Mr. Welsh's reliability or competence in the matter.—D. F. Switzenberg, *Game Division, Michigan Department of Conservation, Lansing 13, Michigan. Received August 26, 1949*

A PRECOCIOUS MALE *MICROTUS PENNSYLVANICUS*

On July 11, 1949, while trapping the Mazinaw Lake region of Lennox and Addington counties, Ontario, I caught a young male *Microtus pennsylvanicus* which showed rather remarkable precocious sexual development. This vole was obviously just past the nesting stage with juvenile pelage and the following measurements: total length, 109 mm.; tail, 27 mm.; hind foot, 19 mm., and weight 10.0 grams. However, upon skinning, the testes were found to be what I have termed "semi-scrotal" in my notes, indicating that they were in the process of migration into the full scrotal position. The testes measured 5.5 by 3.5 mm., which was slightly larger than those of a *Microtus* caught July 9 with a total length of 149 mm. and weighing 26.5 grams. The testes of this latter vole were scrotal and measured 5 by 3 mm.

Microscopic examination of the smears of the testes and epididymes of these two voles revealed a rather startling difference. The smaller one proved to be undergoing active spermatogenesis with all stages represented, including a few mature spermatozoa in the testes. The larger one on the other hand showed no active spermatogenesis beyond a very few primary spermatocytes. Neither had spermatozoa in the epididymes.

The larger of these two voles represents a normal course of development and would no doubt soon have undergone active spermatogenesis, judging by preliminary smear examinations of other microtines which indicate that the critical testis size for spermatogenesis is in the neighborhood of 6 by 4 mm. In contrast to this vole, however, the small individual most certainly represents a highly precocious development. Unfortunately the smears were not examined until a week or so after the vole was captured, and consequently no further examination for possible endocrine gland abnormalities was made. Two female *Microtus*, caught three days before, which were the same size and weight as the one under discussion, were decidedly immature.

All of the above mice are now in the collection of the Carnegie Museum, Pittsburgh, Pa. —JOHN J. CHRISTIAN, *12 Roseland Ave., Fox Chase Manor, Philadelphia 11, Pennsylvania.* *Received September 8, 1949.*

POLYOVULAR FOLLICLES IN THE WOODCHUCK (*MARMOTA MONAX*)

In 1926, Hartman (Amer. Jour. Anat., 37: 1–52, 1926) reviewed the reported data on polyovular follicles and polynuclear ova, going on to augment and discuss this problem with reference to his work with the opossum. He concluded that polyovular follicles were probably the persistent union of the ova in Pfluger's egg tubes, and that since they occurred most often in the opossum with a hyperactive parenchyma, they were probably not the result of concrescence of previously separated follicles. Polyovular follicles were likewise stated as occurring most frequently in young animals. The woodchuck (*Marmota monax*) was not included in the species reviewed by Hartman, and I have been unable to find any mention of this occurrence in the woodchuck in the literature since that time. The following is a report of a woodchuck ovary which contained a large number of polyovular follicles, and apparently supports the theory that these follicles arise from concrescence of previously separated follicles rather than from persistent Pfluger's tubes.

At Tafton, Pike County, Pennsylvania, on July 25, 1938, a female *Marmota* with mature pelage was shot. The ovaries were preserved in Bouin's fluid. Later one ovary was longitudinally transectioned, one-half serially sectioned at seven micra, and stained with Harris's acid haematoxylin and eosin.

This half ovary contained 21 biovular and three triovular secondary follicles. Most of these had at least a bilaminar granulosa, and in a few instances the follicles had a well-developed theca interna and early antrum. There was no evidence of atresia in any of these follicles, all showed clear-cut nuclear staining, well-defined nuceoli and cell membranes. No polyovular primary follicles were found. The most interesting feature of these follicles was the presence of what appears to be all stages in the coalescence of individual follicles to form polyovular follicles. Some biovular follicles were found in which each ovum was surrounded by its own distinct granulosa, which in turn were both surrounded by the same glassy membrane and theca. Another situation existed in which a single developing theca surrounded a bilaminar secondary follicle and an early secondary follicle with but a single layer of flattened granulosa cells. Only the latter granulosa persisted between the ova of these two follicles where they were in contact. A similar situation was seen in one triovular follicle in which the youngest ovum was surrounded by a flattened single-celled granulosa; the oldest was a multilaminar follicle, but not more than one layer of cells existed between the ova at their points of approximation. All degrees of development were found between these follicles and those in which the egg membranes were in complete contact along one side; so that the dividing membranes appeared as one. No polynuclear ova were found.

The absence of any polyovular primary follicles and the presence of all stages of apparent coalescence of secondary follicles from two distinct follicles in a single theca to several approximated ova within a single granulosa and theca strongly suggest, at least in this woodchuck, that polyovular follicles are a result of coalescence rather than Pfluger tube survival. The absence of atresia in these follicles can probably be attributed to the fact that no follicles had reached a stage much beyond early antrum formation, and for the most part were considerably younger than this. Although the age of this animal is not known, it seems likely that it was a fairly young individual.—JOHN J. CHRISTIAN, *12 Roseland Ave., Fox Chase Manor, Philadelphia 11, Pennsylvania.* *Received September 10, 1949.*

FLUCTUATION IN THE POPULATION OF *NEOTOMA CINEREA* (WOODRAT) IN JACKSON HOLE, WYOMING

Within the last eight years an extreme fluctuation in the numbers of *Neotoma cinerea* has been noted in Jackson Hole, Wyoming. In 1941, Mr. James R. Simon, director of the Jackson Hole Wildlife Park at Moran, Wyoming, observed that woodrats were present in great numbers in the entire region. On pack trips into the mountains he found it to be a

nightly occurrence to have several of these animals invade the camps. Other inhabitants of the valley have also attested to the fact that woodrats were numerous around most cabins and deserted mineshafts in 1941.

The writer carried on extensive mammal collecting in Jackson Hole in the summer months of 1948 and 1949. During this time woodrats were found to be very rare. In all of the most likely habitats for *Neotoma* there has been almost a total absence of the species in the last two years. Although several have been collected in old mineshafts, and a few in cliff areas where talus slides were located, the large population observed in 1941 is now lacking. Never during the last two summers of collecting in the region were field camps ever visited by woodrats, even in areas where they were collected in small numbers. Such strong cyclic behavior in *Neotoma* has apparently not been previously recorded.

Since no rodent control projects have recently been in effect in Jackson Hole, it seems probable that the normal complexity of causes governing other mammal cycles may also affect *Neotoma*. If this animal does experience a typical cycle, it must be one of at least five years duration.—N. C. Negus, *Dept. of Zoology, Miami University, Oxford, Ohio. Received September 28, 1949.*

A RECORD OF THE SPOTTED BAT (*EUDERMA MACULATA*) FOR MONTANA

A spotted bat (*Euderma maculata*) was taken at the residence of L. E. Hiner, Billings, Montana, on June 27, 1949, at 11:00 P.M. The animal entered the house through an open door or window. Taken alive and placed in a box, the bat died and was turned over to the author on June 29 for preparation. Since the specimen was still in good shape, a skin and skull was prepared. The specimen has been deposited with the Montana State College at Bozeman.

A search of the literature reveals that this species has been previously recorded only eight times (Durrant, Jour. Mammalogy, 16: 226, 1935; and Hall, *Ibid.*, 20: 103, 1939) as follows: Mesilla Park, New Mexico; Yuma, Arizona; Piru, Mecca, Yosemite Valley, and Kern County, California; Reno, Nevada; and Salt Lake City, Utah. This is the first time this exceedingly rare species has been recorded from farther north than about the 41st parallel.

The specimen, a male, measured as follows: L, 114 mm.; T, 48 mm.; HF, 9 mm.; E, 39 mm.; and FA, 49 mm. Without ossified baculum, the specimen was classified as a subadult.—A. J. Nicholson, *Fish and Wildlife Service, P. O. Box 1381, Billings, Montana. Received July 22, 1949.*

MYOTIS SUBULATUS LEIBII IN VIRGINIA

Records from adjoining states have indicated that the rare bat *Myotis subulatus leibii* probably occurs in Viriginia, but definite records of its presence there have heretofore been lacking. Through the efforts of members of the National Speleological Society, two Virginian specimens have recently been deposited in the U. S. National Museum.

The first (no. 270086) was taken by W. J. Stephenson on November 9, 1940, in Millboro Cave, Bath County. The second (no. 283778) was captured on April 9, 1949, by Miss Nancy Rogers in Hupman's Saltpeter Cave, at 2500 feet elevation, near Williamsville, Highland County. These localities are in the mountainous western part of Virginia, near the West Virginia border. Both bats were adult females and presumably were overwintering in the caves where they were found.—David H. Johnson, *U. S. National Museum, Washington 25, D. C. Received September 16, 1949.*

THE GRAY FOX IN NORTH DAKOTA

On December 15, 1943, Ernest Stredwick, Minot, North Dakota, trapped a gray fox (*Urocyon*) near Minot, Ward County, S. W. ¼, Sec. 11; Twp. 154 N., R. 82 W. (northwestern part of state). Mr. Stredwick came to the community in 1885 when he was about six years of age. He had done considerable hunting and trapping during his life time, but stated

this was the first gray fox he had ever seen or heard of in his locality. Mr. Stredwick presented this specimen to the Biological Surveys collection through Stanley Saugstad.

The late Vernon Bailey (North Amer. Fauna No. 49, p. 166, 1927) wrote the following: "There is only one record for the State and this seems doubtful. In 1833, at Fort Clark, Maximilian (Wied, 1839–1841, Bd. 2, p. 86, 1841) wrote: 'The gray fox (*Canis cinereo argenteus*) and the cross fox (*Canis decussatus*) are likewise found here.' This record seems very questionable, as no other report of their occurrence is to be found so far north in the prairie country. It seems probable that Maximilian confused the silver-gray fox of the genus *Vulpes* with this species, or merely applied the wrong name to the silver-gray. Perhaps the note refers to furs traded by the natives at Fort Clark, but really brought from points farther south. The northern edge of the Black Hills in South Dakota is the nearest point at which gray foxes are known to occur."

There is apparently one other record from this state, a specimen in the State Historical Museum at Bismarck, North Dakota, collected near Wilton, McLean County, North Dakota, about 1942.

The recently acquired specimen is apparently the second authentic record for the state. It is referable to *Urocyon cinereoargenteus ocythous*, and extends its range about 70 miles north-northwest of Wilton, North Dakota.—Viola S. Schantz, *U. S. Fish and Wildlife Service, Washington, D. C. Received August 22, 1949.*

BELDING GROUND SQUIRREL IN NORTHWESTERN UTAH

Three male specimens of *Citellus beldingi crebrus* were taken by me at Standrod in the Raft River Mountains, northwestern Utah, Boxelder County, on July 16 and 20, 1949. Colonies of this species live in wild hay and alfalfa fields south of Standrod, which is on the Utah-Idaho line. External measurements of two adult males agree with measurements given by Hall (Mammals of Nevada, Univ. Calif. Press, 1946). This seems to constitute a new record for this species in Utah. Two of the specimens have been placed in the Museum of Vertebrate Zoology at the University of Utah. The third is at Weber College, Ogden, Utah.—Richard D. Porter, *Dept. Vert. Zool., Univ. Utah, Salt Lake City, Ogden, Utah. Received August 25, 1949.*

THE WOODRAT, *NEOTOMA MAGISTER*, IN VENANGO COUNTY, PENNSYLVANIA

Although the woodrat, *Neotoma magister* Baird, is common throughout much of the central and eastern parts of the state, it has not previously been reported in the Allegheny Plateau of northwestern Pennsylvania. The following observations were made during the spring and summer of 1948 while making a survey of the mammals of northwestern Pennsylvania, (Pittman-Robertson Project 20-R, Federal Aid in Wildlife Restoration Program).

Nine specimens were trapped on the cliffs 1½ miles NE of Kennerdell, and their characteristic large piles of sticks and trash were found on ledges in three other localities in Venango County: 1 mile SW of Utica; ½ mile S of Polk; and 6 miles SW of Franklin. Similar habitats in Warren, northern Jefferson, and McKean counties were examined, but no evidence of these rats was found.

In Venango County, the occurrence of *Neotoma* was associated with dry ledges and rock slides of a massive sandstone that outcrops near the tops of the hills. West of the Allegheny River such outcrops are local and small in extent and disappear entirely in eastern Mercer and Crawford counties.

The specimens, seven males and two females, have been deposited in the Pennsylvania Mammal Survey Collection, Section of Mammals, Carnegie Museum, Pittsburgh, Pennsylvania.—Neil D. Richmond and Harry R. Roslund, *Pennsylvania Game Commission Harrisburg, Pennsylvania. Received October 10, 1949.*

DDT PROTECTS BAIT FROM ANTS

Collecting small mammals in the South during the summer months, or for that matter whenever the temperature averages more than 50° F., is a discouraging job because of the havoc wrought by ants and other insects to the bait and the trapped animals. I understand that insects are a plague during warm weather in other parts of the country also; hence, the following suggestion may be of general interest to collectors. Mix with the usual peanut butter combination bait three (3) per cent by weight of commercial white DDT powder, and no insect will molest the bait. Using museum special traps, I tried this mixture with great success during the months of June, July, and August of 1948 in central South Carolina; and, although the trapped mammals were often attacked by ants and rendered useless as specimens, the bait itself was never molested.—ROBERT H. COLEMAN, *Route 8, Box 615, Charleston, South Carolina. Received September 24, 1949*

RECENT LITERATURE

(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

[Reprints of this section may be purchased from the Corresponding Secretary]

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LIST OF MEMBERS

LIST OF MEMBERS OF THE AMERICAN SOCIETY OF MAMMALOGISTS

(Additions have been made to this list to February 20, 1950. Corrections and changes of addresses should be sent to the corresponding secretary—Donald F. Hoffmeister)

*Life Member †Nominee for Annual Member

Honorary Members

ANDERSON, RUDOLPH M., 58 Driveway, Ottawa, Canada.....(Charter) 1947
CABRERA, ANGEL, Calle 64, no. 584, La Plata, Argentine.....(Charter) 1947
MILLER, GERRIT S., JR., U. S. National Museum, Washington 25, D. C...(Charter) 1941

Life Members and Annual Members

ADAMS, ARTHUR K., Univ. Michigan, Mus. Annex, Ann Arbor, Mich..... 1948
ADAMS, CHARLES C., 149 Manning Blvd., Albany 3, N. Y.....Charter
†ADAMS, DAVID A., 1016 Isleworth Ave., Charlotte, N. C..... 1949
ADAMS, I. C., JR., 3 N. Glenwood, Columbia, Mo..... 1941
ADAMS, LOWELL, Forest Exp. Sta., Missoula, Mont..... 1938
AGACINO, E. MORALES, Instituto Espanol de Entomologia, Museo Nacional de Ciencias Naturales Hipodromo, Madrid, Spain..... 1933
*ALCORN, J. R., Rt. 1, Box 19a, Fallon, Nev..... 1939
ALDERSON, LOUIS EVERETT, Box #39, Hamlin, W. Va..... 1947
ALDOUS, CLARENCE M., Fish & Wild. Serv., P.O. Box 1306, Albuquerque, N. M.... 1931
ALDOUS, SHALER E., Fed. Aid Div., Fish & Wild. Serv., Washington, D. C..... 1927
*ALEXANDER, MISS ANNIE M., Suisun, Calif.....Charter
ALEXANDER, MAURICE M., Dept. Forest Zool., N. Y. State Coll. of Forestry, Syracuse 10, N. Y..... 1947
ALLAN, PHILLIP F., 1801 Carlton, Ft. Worth, Tex..... 1931
ALLEN, ARTHUR A., Fernow Hall, Ithaca, N. Y.....Charter
ALLEN, DURWARD L., Patuxent Refuge Reserve, Laurel, Md..... 1938
ALLEN, E. ROSS, Silver Springs, Fla..... 1948
ALLEN, GEORGE W., State Game & Fish Comm., 412 State Capitol, Atlanta, Ga... 1948
†ALLEN, HARRY, 6 Lower Jones Rd., Hopedale, Mass..... 1949
ALLIN, A. E., Provincial Lab., Ft. William, Ontario, Canada..... 1942
ALLISON, RAY, Dept. Zool. & Entom., Box 5215, State Coll. Sta., Raleigh, N. C... 1948
ALLRED, WARREN J., Afton, Wyo..... 1946
AMADON, DEAN, American Mus. Nat. Hist., New York 24, N. Y..... 1938
†ANDERSON, ELSIE P., 46 N. Ave. C., Canton, Ill..... 1949
ANDERSON, JOHN M., 38 N. Madison St., Port Clinton, Ohio..... 1939
ANTHONY, H. E., American Mus. Nat. Hist., New York 24, N. Y.....Charter
ARCHBALD, DAVID, 172 Linwood Ave., Buffalo 9, N. Y..... 1948
*ARCHBOLD, RICHARD, American Mus. Nat. Hist., New York 24, N. Y..... 1929
†ARNOLD, DAVID A., 519 Holmes St., State College, Pa..... 1949
ARNOLD, LEE W., U. S. Fish & Wild. Serv., Box 1306, Albuquerque, N. M..... 1940
ATZ, JAMES W., 697 Tremont Ct., Orange, N. J..... 1936
AUSTIN, OLIVER L., SR., Tuckahoe, N. Y..... 1930
AXTELL, HAROLD H., Buffalo Mus. Science, Buffalo 11, N. Y..... 1945
BACHRACH, Max, 370–7th Ave., New York 1, N. Y..... 1947
BAILEY, ALFRED M., Colorado Mus. Nat. Hist., Denver, Colo.....Charter
BAILEY, HAROLD H., Rockbiridge Alum Spgs. Biol. Lab., Rt. 2, Goshen, Va.....Charter
*BAILEY, JOHN W., 27 Willway Rd., Richmond 21, Va..... 1927
BAILY, FISHER C., 1229 Ralston St., Reno, Nev..... 1945

BAKER, BERTRAM D., General Delivery, Monte Vista, Colo. . . . 1948
BAKER, JOHN H., 1165 Fifth Ave., New York, N. Y. . . . 1941
BAKER, ROLLIN H., Mus. Nat. Hist., Univ. Kansas, Lawrence, Kans. . . . 1938
†BAKKEN, ARNOLD, Zool. Dept., Univ. Wisconsin, Madison, Wisc. . . . 1949
BALDWIN, PAUL H., Mus. Vert. Zool., Univ. California, Berkeley 4, Calif. . . . 1941
BALDWIN, WILLIAM P., JR., Savannah Nat'l. Wild. Refuge, Port Wentworth, Ga. . . . 1939
BALL, K., Dept. Biol., Univ. Alabama, University, Ala. . . . 1948
BALMER, CHARLES V. B., 309 Armstrong Rd., Hampton, Va. . . . 1948
BANFIELD, A. W. FRANK, Dom. Wild. Serv., Dept. Mines & Resources, Ottawa, Canada . . . 1938
*BANNON, HENRY, First Nat'l. Bank Bldg., Portsmouth, Ohio . . . 1922
BANTA, BENJAMIN H., P.O. Box 605, Reno, Nev. . . . 1942
BARBOUR, ROGER WILLIAM, Oglebay Inst., Wheeling, W. Va. . . . 1941
BARD, FRED G., Provincial Mus., Regina, Saskatchewan, Canada . . . 1948
BARKALOW, FREDERICK S., JR., Box 5215, State Coll. Sta., Raleigh, N. C. . . . 1934
BARNES, CLAUDE T., 359–10th Ave., Salt Lake City, Utah . . . Charter
BARNES, WILLIAM B., 10 State House Annex, Indianapolis, Ind. . . . 1942
BARRETT, CHARLES H. M., 1339 Valley Pl., S.E., Washington 20, D. C. . . . Charter
BARRINGTON, B. A., King Coll., Bristol, Tenn. . . . 1940
BARTHOLOMEW, GEORGE A., JR., Dept. Zool., U.C.L.A., Los Angeles 24, Calif. . . . 1942
BARTO, MISS ELIZABETH, Lab. Vert. Biol., Univ. Michigan, Ann Arbor, Mich. . . . 1938
BARTSCH, PAUL, Lebanon, Lorton, Va. . . . 1921
BASSETT, NEIL R., Wild. Dept., Utah St. Ag. Coll., Logan, Utah . . . 1948
BATCHELDER, CHARLES F., 7 Kirkland St., Cambridge, Mass. . . . Charter
BATES, MARSTON, The Rockefeller Foundation, 49 W. 49 St., New York 20, N. Y. . . . 1944
BATTS, H. LEWIS, JR., 4930 Washtenaw Rd., Ypsilanti, Mich. . . . 1947
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*BAUMGARTNER, LUTHER, B. F. Goodrich Co., Boyce Thomson Inst., Yonkers, N. Y. 1937
BAXTER, WILLIAM, JR., 27 Virginia Ave., Rehoboth, Del. . . . 1942
BEACH, FRANK A., Dept. Psychol., Yale Univ., New Haven, Conn. . . . 1947
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BEAN, ROBERT, Chicago Zool. Park, Brookfield, Ill. . . . 1946
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BECKER, EDWIN J., 123 S. Harvard, Albuquerque, N. M. . . . 1946
BEEBE, WILLIAM, 33 W. 67th St., New York, N. Y. . . . Charter
BEECHER, WILLIAM J., Chicago Nat. Hist. Mus., Chicago 5, Ill. . . . 1947
BEER, JAMES R., Div. Entom. & Eco. Zool., Univ. Minnesota, St. Paul 1, Minn. . . . 1940
BEHLE, WILLIAM H., Dept. Biol., Univ. Utah, Salt Lake City, Utah . . . 1936
BEIDLEMAN, RICHARD G., Zool. Dept., Colo. A. & M. Coll., Fort Collins, Colo. . . . 1948
†BELL, IAN L., P.O. Box 448, Provo, Utah . . . 1949
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BELLROSE, FRANK C., JR., Ill. Nat. Hist. Survey, Havana, Ill. . . . 1941
†BELSTAD, WALTER C., 845 Bellevue Ave. No., Seattle 2, Wash. . . . 1949
BENCHLEY, BELLE J., Zoological Garden, San Diego, Calif. . . . 1942
BENNETT, LOGAN J., Fish & Wild. Serv., 2248 Interior Bldg., Washington, D. C. . . . 1939
BENNETT, MARY A., Western Ill. State Coll., Macomb, Ill. . . . 1947
BENNINGTON, ELWIN E., Kelly, Iowa . . . 1941
BENSON, SETH B., Mus. Vert. Zool., Univ. California, Berkeley 4, Calif. . . . 1928
†BENSON, WALTER A., Dept. Zool., Univ. Brit. Col., Vancouver, B. C., Canada . . . 1949
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BEULE, JOHN D., 312 W. 3rd St., Beaver Dam, Wisc. . . . 1939
†BIGGS, JOSEPH D., 6624 First St., N.W., Washington 12, D. C. . . . 1949

BILADEAU, TED D., 1815 W. Jefferson St., Boise, Idaho 1946
†BINFORD, ROBERT T., JR., 4232 Cliff Rd., Birmingham, Ala. 1949
BINGHAM, LARAY G., 2068 Madison, Ogden, Utah 1948
BIRDSEYE, CLARENCE, Eastern Point Blvd., Gloucester, Mass. 1933
BISHOP, SHERMAN C., Dept. Biol., Univ. Rochester, Rochester, N. Y. ..... Charter
BLACK, GEORGE O., Cornell Rd., R #, 1 Box 227, Oswego, Ore. 1941
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BLAIN, ALEXANDER W., 2201 Jefferson Ave., E., Detroit, Mich. 1926
BLAIR, W. FRANK, Dept. Zool. & Physiol., Univ. Texas, Austin, Tex. 1936
BLANC, FRANCOIS E., Blvd. Maillot 42, Neuilly Sur Seine, France 1946
BLOSSOM, PHILIP M., 2737½ W. 15, Los Angeles 6, Calif. 1929
BLUNTSCHLI, HANS, Anat. Inst., Univ. Bern, Buhlstr. 26, Bern, Switzerland 1930
BLYTH, DAVID, 2337 Agler Rd., Columbus 11, Ohio 1939
BOATMAN, PAUL A., 744 E. Wabash Ave., Carthage, Ill. 1948
BOEHM, EARL W., 1304-6th Ave., Bay City, Mich. 1946
*BOLE, BENJAMIN P., JR., Cleveland Mus. Nat. Hist., 2717 Euclid Ave., Cleveland, Ohio 1930
†BOMBINO, FRANK L., Box 243, Rt. 1, Clearwater, Fla. 1949
BOND, RICHARD M., 3322 S.W. Fairmount Blvd., Portland, Ore. 1938
BOOTH, ERNEST S., Walla Walla Coll., College Pl., Wash. 1941
*BORDEN, JOHN, Box 442, Muskegon, Mich. 1928
†BORDEN, RICHARD, Nat'l. Wild. Fed., 20 Spruce St., Boston, Mass. 1949
BORELL, ADREY E., Soil Conserv. Serv., P.O. Box 1348, Albuquerque, N.M. 1925
BOULWARE, JEAN T., 428 N. Livingston, Madison 3, Wisc. 1941
†BOURLIERE, FRANCOIS, 8 Rue Huysmans, Paris 6, France 1949
BOYCE, ARLOW P., D-7 Wells Hall, Mich. State Coll., East Lansing, Mich. 1947
BOYER, GEORGE F., R.R. #1, West Sackville, N.B., Canada 1947
BOYER, RICHARD H., Nat'l. Pk. Serv., Kings Canyon Nat'l. Pk., Calif. 1941
BRANDBORG, STEWART M., Coop. Wild. Res. Unit, Moscow, Idaho 1946
BRECKENRIDGE, W. J., Mus. Nat. Hist., Univ. Minnesota, Minneapolis, Minn. 1932
BRITTAN, MARTIN R., So. Dakota Sch. Mines & Tech., Rapid City, S.D. 1947
BROADBOOKS, HAROLD E., Stephen F. Austin State College, Nacogdoches, Texas 1939
BRODIE, ARNOLD F., 54 Ashton St., Dorchester, Mass. 1948
BROHN, ALLEN, 110 Wild. Cons. Bldg., Columbia, Mo. 1945
*BROOKE, RAYMOND J., JR., 609 Woodcrest Ave., Ardmore, Pa. 1944
†BROOKS, ALLAN C., Hope Bay, Pender Island, B.C., Canada 1949
BROOKS, EARLE A., 166 Plymouth Rd., Newton Highlands, Mass. 1921
BROOMAN, RONALD C., c/o Bank of Montreal, Kitchener, Ontario, Canada 1938
BROWN, CHARLES P., R.D. #2, Altamont, N.Y. 1939
BROWN, ELMER E., Box 97, Davidson, N.C. 1944
BROWN, F. MARTIN, Fountain Valley School, Colorado Springs, Colo. 1926
BROWN, N. RAE, Faculty of Forestry, Univ. New Brunswick, Fredericton, N.B., Canada 1946
†BROWN, ROBERT Z., 4632 York Rd., Baltimore 12, Md. 1949
BROWN, V. E., Dept. Zool., Marquette Univ., Milwaukee, Wisc. 1942
†BROWN, WILLIAM H., Dept. Zool., Univ. Arizona, Tucson, Ariz. 1949
BRUCE, WILLIS H., 630 19th Ave., Longview, Wash. 1946
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BRYANT, MONROE D., Austin Coll., Sherman, Tex. 1940
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CALL FOR PAPERS

Titles for papers for the 30th Annual Meeting of this Society should be sent at once to the Corresponding Secretary. Give the title, time required for presenting your paper, equipment needed for its presentation, and a brief summary if you desire. Papers are urgently needed to make the program a success. Send the above information to *Dr. Donald F. Hoffmeister, Museum of Natural History, University of Illinois, Urbana, Illinois.* **Titles must be received by June 2.**

Rare Numbers of the Journal

There are many requests for certain numbers of the JOURNAL that the Society no longer has. If you have some of these which you would be willing to dispose of, please inform the *Corresponding Secretary.* He will give you the names of those seeking them. The rare numbers are: Vol. 1, nos. 1–3; Vol. 2, nos. 1–4; Vol. 3, nos. 2–4; Vol. 5, nos. 1–4; Vol. 20, nos. 1–2; Vol. 21, nos. 1–4; Vol. 27, no. 1; Vol. 29, nos. 1–2

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NOTICE OF ANNUAL MEETING

The Thirtieth Annual Meeting of the American Society of Mammalogists will be held at Mammoth Hot Springs, Yellowstone Park Headquarters, in Yellowstone National Park, from June 25 to June 28, 1950. Sessions will be held at the government canteen building unless circumstances are such that it seems more desirable to transfer to the Yellowstone Park Company recreation hall.

Accommodations for room and board are as follows, according to rates for 1949:

Mammoth Hotel—room without bath:

1 person	$3.75
2 persons in room	$6.00

Mammoth Hotel—room with bath:

1 person in room	$6 or $7.00
2 persons in room	$9.50 or $10.50

Mammoth Hot Springs Hotel Cottages—with hot & cold water:

1 person in a room	$2.75 per person
2 persons in a room	$2.00 per person

Rooms with twin beds come slightly higher. Cottages with twin beds, showers, lavatories, and toilets:

1 person	$5.00 per person
2 persons	$3.75 per person

Tourist cabin lodgings vary from $1.25 per person to three room cabins accommodating four persons for $4. Those using the tourist cabins usually provide their own bedding and often cook in the cabins.

Meals can be obtained at the hotel dining room, at the hotel grill, at the Pryor's Coffee Shop, and at the Mammoth cafeteria. The cost of meals will be dependent upon the selection of items made by the individual from the menu; good food can be obtained at a nominal cost.

An interesting program, with emphasis on field trips, is in store. The local committee on arrangements is as follows:

Victor H. Cahalane, *Chairman*
Lowell Adams
David de L. Condon
Ian McT. Cowan
Paul D. Dalke
Stephen D. Durrant
Reed W. Fautin
William L. Jellison

Philip L. Wright

TO PROSPECTIVE MEMBERS OF THE AMERICAN SOCIETY OF MAMMALOGISTS

As stated in the by-laws, the objects of the Society are "The promotion of the interests of mammalogy by holding meetings, issuing a serial or other publication, aiding research, and engaging in such other activities as may be deemed expedient."

So far the Society has vigorously pursued these objectives. The meetings have been held regularly, and become more important yearly. These are attended by many of the leaders in the field of mammalogy. In addition, the Society has been active, and is influential, in many conservation projects.

One of the most important functions of the Society is the publication of THE JOURNAL OF MAMMALOGY. This journal has been published quarterly now for more than 30 years, and it has become indispensable to all professional mammalogists, wildlife managers, naturalists, sportsmen, and others interested in mammals. The Journal is the only one in North America devoted entirely to mammalogy, and it holds high rank as a scientific publication.

Annual dues for members, which include a subscription to the **Journal of Mammalogy,** are $4.00. Any member has the right to attend meetings, participate in the activities of the club, and hold office.

Apply to the *Corresponding Secretary* or to members of the Committee on Membership for application blanks. Membership is dated from the nearest January, unless otherwise requested, although formal election does not take place until the annual meeting of the Society following the receipt of application.

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